POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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A. W. KRAMER, RICHARD H. MORRIS, Associate Editors.

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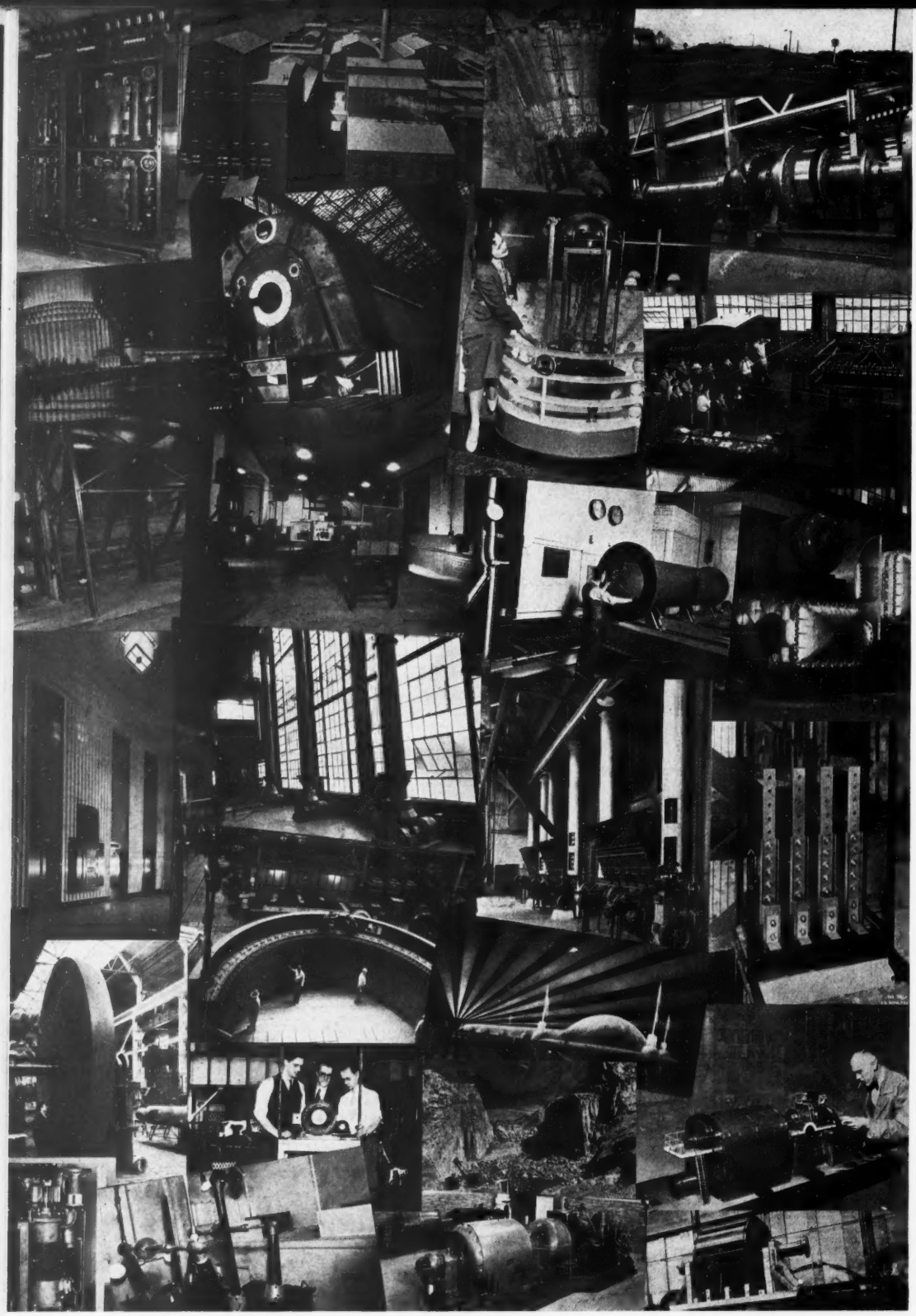
THE YEAR'S PROGRESS IN PICTURES



HERE are shown some of the developments by which we measure progress in the power industry during the year 1934. The views, selected at random, portray developments of considerable variety, from the new plant of the world's largest distillery to new applications of the photocell or the first sodium vapor illuminated highway but all of them are representative and reflect the character of development during the past year.

With the Editors

Whither?

CHANGE is in the air. Since power came into wide use, tremendous changes have resulted in production methods and social conditions. Now the emphasis is being placed on altering the economic system and the result may be even greater changes in industrial methods and the control of the lives of individuals.

Under the individual system of competition, each man gets what he can and spends it or invests it, retaining the ownership of what he has and the right to do with it as he pleases. This is the system that has existed in most of the world until recently, resulting in great productivity, especially in those countries where power has been largely used, and in returns to individuals roughly in proportion to services rendered by them. Opinions differ greatly as to the fairness of the system but, on the whole, it has resulted in rising standards of living and, up to the present generation, experiments in introducing a better system have been unsuccessful. Various other economic systems have been proposed and some are now being tried out on a grand scale, our own country being, apparently, headed for a composite experiment with several, with the ultimate objective not clearly defined.

In a thoughtful discussion of the situation in the American Magazine, Professor Neil Carothers points out certain trends and fundamentals of the five systems of economic effort. His analysis is worth careful thought and is, therefore, briefly summarized. The one thing clearly evident from our present situation is the power of life or death over every economic activity that is held by the ballot box and through that by the political leaders who can gain and hold power.

The five systems are: Individualism, liberalism, communism, fascism, socialism. Individualism is the competitive system which has been in existence and under which the function of government is to keep peace and provide protection to people and property rights. Government ownership of or interference with industry except to maintain fair competition and prevent cheating are frowned upon, also all forms of paternalistic activity.

Liberalism endorses the profit motive for human activity but admits the value of coöperative organization to secure better conditions for the weak and handicapped and endorses social-legislation, where careful analysis shows that such activities as regulation of competitive industry, old-age pensions and the like will be socially worth more than they cost. It does not favor wide government ownership of industry or direct management but admits that in some industries close regulation may be desirable in the interests of society.

Communism, while rather vague in its economic plans, opposes all private ownership of property, believes in the overthrow of capitalism by violent warfare, that interest, rent and profits are unjust and that all return from industry should go to the workers. All activity should be coöperative under state control; all property should be owned in common.

Fascism advocates a single, absolute control of all individuals and all industry; a dictatorship which will ruthlessly regiment everybody and everything in what it conceives to be the national interest, without regard to any private interest. It maintains a capitalistic and competitive set up but would regulate competition and dictate to capital and to labor whatever terms it chooses, and would assume power to regulate marriage, children, religious and political belief, freedom of speech and standards of living of the individual.

Socialism seeks coöperation and common ownership, with ending of the profit motive, the object being to abolish poverty, unemployment and dependence and the production for general use of products that will be distributed according to needs. The method of accomplishing this is not clearly defined and socialists differ greatly as to a practical program.

From the present agitation, one of these systems, or a combination, will emerge in each country and it is for the people of this country to decide whither they wish to go.

Professor Carothers points out some economic facts that must be considered in making a wise choice. First, while our standard of living is high, our economic system does not produce sufficient to give luxurious living to all, no matter how the product is distributed. Capital and raw material are not sufficient to accomplish this.

Second, if industry is to progress, capital must be provided. If individuals are not allowed to save and invest, capital must be provided by the whole people by reducing their standard of living so that part of the product of industry and agriculture will be saved to provide the needed capital.

Third, while interest and the increase of the wealth of the country are adding to the holdings of property owners, incomes of workers are also rising and their standard of living is coming nearer to that of the well-to-do. Although the wealthy may be increasing their estates, income to workers is also increasing and, in addition, large property owners are heavily taxed for social service to workers. A large part of the income of the wealthy goes to charity and philanthropy and much of the rest is invested at low return as capital to provide means for workers to earn wages.

These facts should be taken into consideration when deciding whither we want to go; also whether it is desirable to attempt a problematic gain of economic security at the risk of state-control and political domination of all individual life and activity.

Readjustment POWER

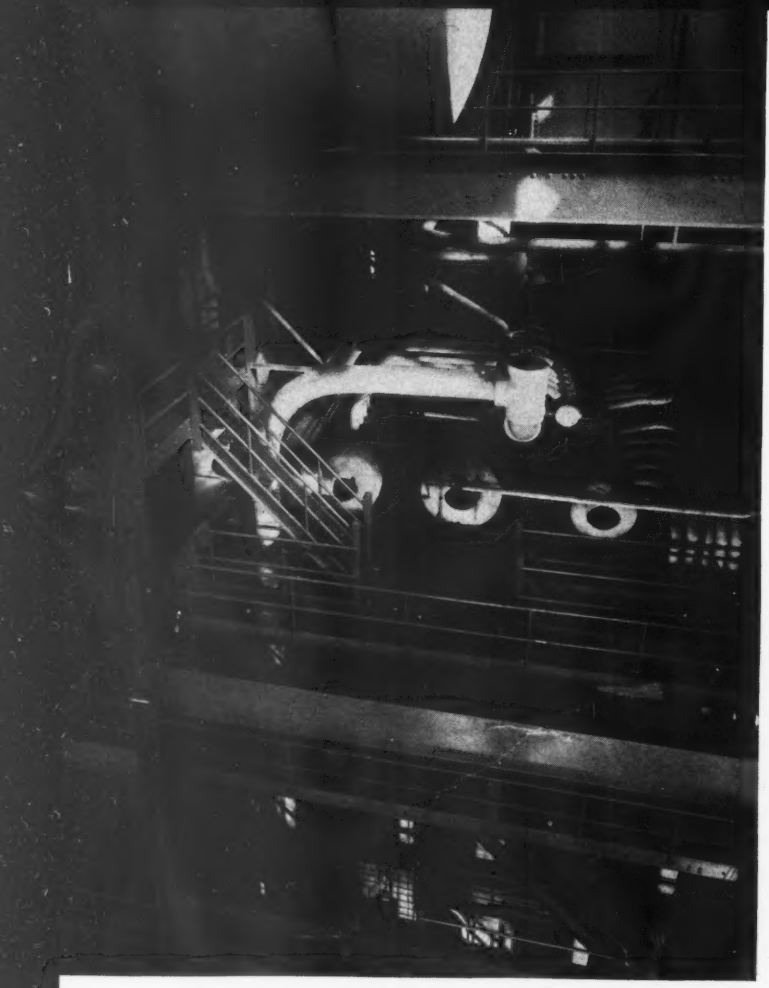


Fig. 1. A View in the boiler plant of the new Hiram Walker Distillery.

PROGRESS" said Vladimir Karapetoff recently[1], "proceeds by jerks." To bear out his contention, this ever interesting and youthful professor of electrical engineering at Cornell University proceeded to compare social and economic progress to what goes on in the slow heating of a mixture of two gases in a closed vessel. To say that the temperature rise is gradual is a correct "over-all" statement of the phenomena, but when it is considered from a molecular standpoint we find quite a different state of affairs. For instead of the slow uniform process our thermometer leads us to believe is there, we find an incomprehensible number of particles rushing about madly, colliding, rebounding, moving in all directions with little resemblance of order. At a given moment, certain molecules may be rushing about at almost infinite speed only to be stopped or deflected a moment later by other molecules moving in opposite directions. And yet when taken as a whole this apparent chaos leads to an orderly effect. As Karapetoff puts it, "A complete determinism statistically; and a chaos, a bedlam, individually." Substitute human beings for the molecules and what we call society or civilization for the gas and we get an idea of how individual actions fit into the general picture of progress. What seems to be bedlam at close range will look to future historians as a microscopic gain towards something permanently good in the story of civilization.

We cannot help thinking about this view of things in presenting this review of developments in the power field during the year, because in presenting a review of anything one unconsciously attempts to interpret the facts present in the case in terms of trends. What these trends are with a given set of facts depend upon the personal opinions and prejudices of the reviewer and quite often upon what he had for breakfast.

Considering the facts and events relating to the power industry during the year, it is difficult to interpret them in terms of a trend. There have been many developments in all branches of the field but we are still viewing them at too close a range to grasp their collective significance. Now, of course, this is not important because the individual developments still retain their interest and that after all is what we are principally concerned with.

Year Has Been One of Readjustment

To be most nearly correct, the year has been one of readjustment. This is particularly true with respect to general power plant practice. While there was a considerable amount of new plant construction during the year, the greatest activity was in the modernization and rehabilitation of old plants. Plants built a number of years ago have been found to be out of step so to speak with economic conditions so it has been expedient to effect their modernization. In other words, they have had to be readjusted to present conditions. This work has involved every branch of power plant activity from coal handling to meter reading. Hand firing has given way to stoker or pulverized coal or oil firing, steam temperatures and pressures have been raised, heat balances of small plants improved, more adequate instrument installations have been made, old generating units have been replaced with new efficient units. In the central station field there has been a constant effort to reduce cost of operation. Plants built five to ten years ago at from 100 to 125 dollars per kw. today have to compete with plants costing from 65 to 100 dollars per kw., naturally, every effort has been made to counteract the high fixed charges on such plants by improved economy of operation.

Stage Set for Building 10,000 B.T.U. per Kw. Hr. Plants

Insofar as the central station field is concerned, the year marks the beginning of the end of the power plant era which began from 1920 to 1924. Nearly all of the features which saw their beginning in those

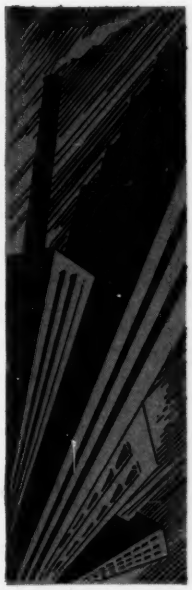
[1]Progress by Jerks, Electric Journal, Aug., 1934, p. 316.

Characterizes all Phases of PLANT DEVELOPMENT

years have now reached the utmost in their development and we are looking forward to new things. As pointed out in the following article, the stage is now set for building a 10,000 B.t.u. per kw. hr. plant of any of several different types, a remarkable achievement in view of the 20,000 to 23,000 B.t.u. per kw. hr. rates which prevailed before the regenerative cycle, reheat practice, pulverized coal and other modern developments came into the picture. But if 10,000 B.t.u. per kw. hr. seems remarkable compared to 20,000, far seeing minds today are looking toward rates far below that. New binary vapor cycles are being investigated and new chemical cycles are being experimented with and rates of 5000 B.t.u. per kw. hr. have been mentioned in connection with such developments but of course only the future can testify to the soundness of these ideas.

A similar though not exactly parallel condition exists in the electrical field with respect to certain practices. Here, too, we are on the verge of new developments which may revolutionize electric transmission, distribution and switching. As far as generator practice is concerned in point of efficiency and reliability at least there is little room for further improvement. Generator efficiencies of around 97 per cent are possible today and transformers can be built with efficiencies better than 99 per cent.

It is in switching, in transmission practice and in methods of control that the future holds forth promise of startling developments. The day of the oil circuit breaker that rivaled a gas tank in size and oil storage capacity is about over. Ever since the oil circuit breaker was first developed its size has been increasing and also its cost. In some of the large outdoor high voltage breakers, the quantity of oil involved was enormous. In the last few years, however, new ideas of circuit opening have been evolved and a more fundamental knowledge of the basic principles involved has led to new possibilities in this direction. This year in the design of the new circuit breakers for the 287,000 v. Boulder Dam circuits we get a glimpse of a design which differs radically from the conventional. It is not to be assumed that these Boulder breakers are in any way indicative of future design but they do mark the beginning of the end of a practice in circuit breaker design of which the best that can be said for it is that it was expedient.



The Boulder Dam circuit breakers are not the only indication of a change in circuit breaker practice. In a demonstration at one of the large electrical manufacturing companies this year, a group of engineers saw an interruption of energy of some 250 kv.a. occur so fast as not to fuse a wire hardly larger than a human hair. This took place not in a conventional circuit breaker or in any circuit breaker at all, but in a grid controlled mercury arc rectifier. However, if the thing can be done in a rectifier, it should be

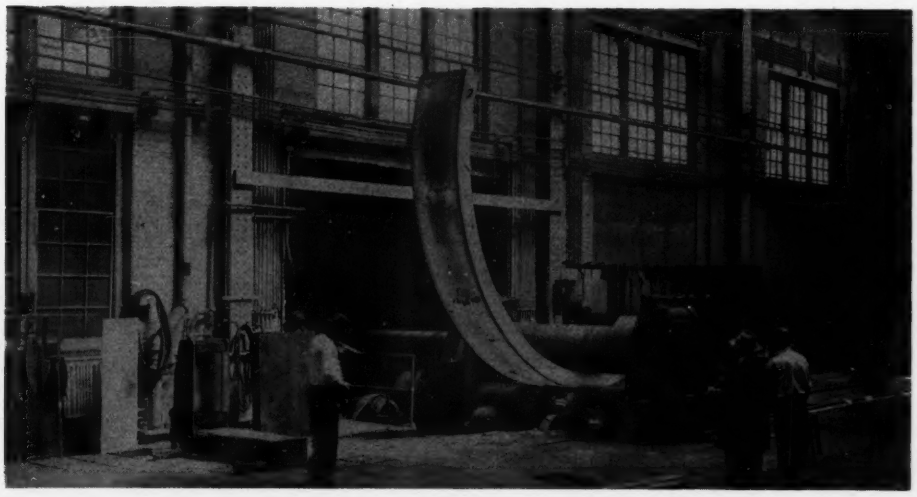


Fig. 2. Rolling a 15 ton slab of white hot steel for a rotor flywheel. One of the first steps in the fabrication of a waterwheel generator rotor rim for one of the Kanawha Valley Power Co. units in Virginia is shown here. (Photo, General Electric)

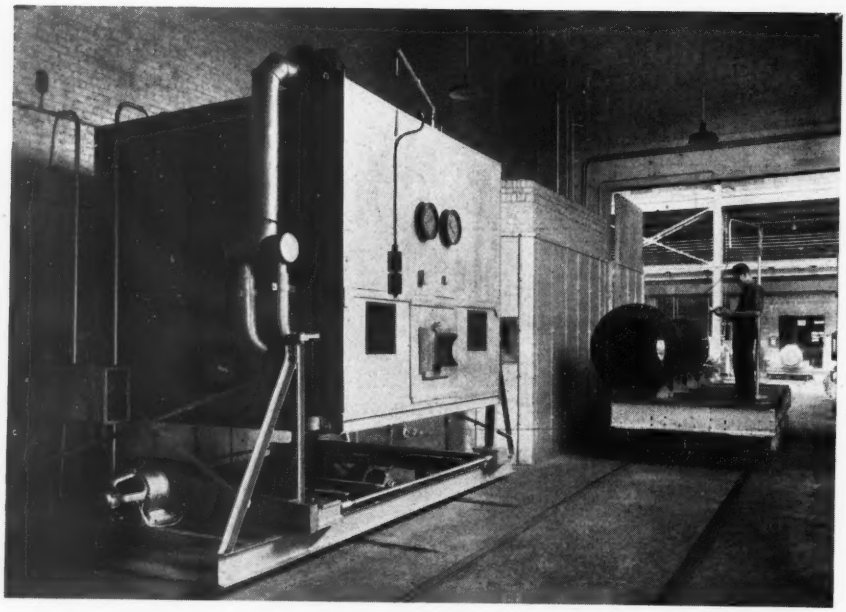


FIG. 3
MODERN METHODS OF CONSTRUCTING POWER EQUIPMENT INSURE RELIABILITY.

This is a view of the x-ray room for x-raying manufactured parts. A welded heat exchanger is shown on the battery driven truck. The x-ray room completely, shielded, is at the left. This equipment involves complete push button control. (Photo courtesy, Westinghouse)

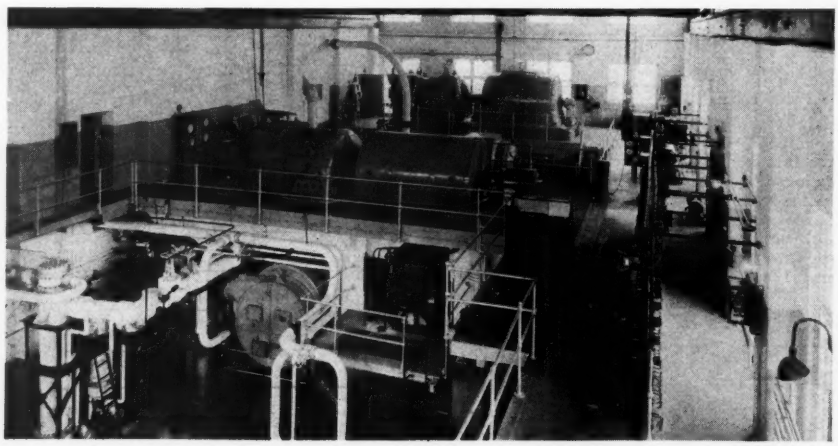
possible to do so in a circuit breaker. For a number of years the vacuum tube has been talked of as a possible circuit opening device but the difficulty has been that the efficiency of the ordinary tube as a current carrying device is undesirably low. In the grid controlled rectifier, however, we have a tube which has an unusually high efficiency as pointed out more fully in the article beginning on page 586.

Electric Control Tendencies

In the control and conversion of electrical energy too, so many new elements have entered the picture that it is difficult, if not impossible, to predict the course of future development. Already, the thermionic tube has revolutionized the field of electrical control but the surface has barely been scratched, so to speak. The possibilities inherent in the thermionic tube are so stupendous that the predictions of the most extreme enthusiast are likely to fall short. Surely no electrical engineer conversant with the details of the research work in television which has been in progress at the R.C.A. laboratories during the past few years will ever question the capabilities inherent in the vacuum tube regardless of in what respect. In the detailed review of electrical developments that follows we have been able to mention only a few of the more important developments and applications in vacuum tube practice, but there are enough to show that the vacuum tube is not merely a fragile thing which functions in some mysterious manner only in a radio receiver. It is truly an Aladdin's lamp, capable of multiplying the usefulness of everything it touches.

Hydroelectric Practice

In hydroelectric practice again the future trend is not clear, despite the great government projects which have been in course of construction during the year. Perhaps in making this statement we are thinking more in terms of the economics of hydroelectric practice than we are of its technical aspects, for these seem quite well defined. The hydraulic turbine is a remarkably well developed machine and with present



BUILT AT 43 DOLLARS PER KW. AND WILL PRODUCE A KILOWATT FOR 10,000 B.T.U.

This is the turbine room of the Taunton plant referred to on page 565. It is a remarkably low priced plant and with the arrangement set up for sale of steam will operate at unusually high economy.

full load efficiencies of around 94 per cent leaves little room for further improvement. The main efforts today are being directed toward the improvement of efficiency for conditions of head and loading different from that of maximum.

Hydroelectric energy in the United States, so far as the public supply is concerned, is an important factor and is likely to be a more important one when the large projects now planned are completed. At the present time as pointed out in the section of hydroelectric developments, about 40 per cent of the electric energy generated for public consumption in the United States is produced by water power. Thus far, this hydroelectric development has been along conventional economic lines. With the development of the new large scale government projects, however, a new element enters the picture—the development of natural resources for the benefit of the community as a whole without much regard to so-called sound economic principles. The manner in which any individual regards this new element depends again upon his personal opinions, prejudices, political views or his purse, but the fact remains that it is an actuality and its influence is bound to be far-reaching. Certainly, it cannot be denied by any sensible person that the coördinated development of a great fertile valley, such as the Tennessee, rich in natural resources, for the benefit of the people is anything but a desirable move. These matters, though not technical, should, nevertheless, be of great interest to engineers, particularly hydroelectric engineers, since they are bound to have a marked effect upon the future development of our power systems and upon the use of power.

Certainly, thus far, the construction of such great projects as Boulder Dam, has stimulated engineering methods and practice to a remarkable degree. When one realizes the difficulties involved and the enormous scale of the undertaking and then studies the methods which have been developed, in the actual construction, it becomes evident that so far as engineering skill is concerned we need have no fear of tackling any problem that comes our way.

Considering the power industry as a whole, as was pointed out before, there has been considerable activity. The list of plants on page 565 involving new installations of power generating equipment is not presented as being complete but it is typical and indicates the type of plant in which most of the activity resided. About 50 per cent of the plants listed in the tabulation are new, the others involved modernization in a major degree. Some of these plants such as that of the Hiram Walker Distillery at Peoria were outstanding in their design and represent a type of engineering that a few years ago was to be found only in large central stations.

While no new central stations went into operation during the year, three have been under construction, Conners Creek, Port Washington and the addition to Richmond Station. Each of these represent different types of engineering practice but all are of considerable interest, Conners Creek particularly so because it represents the application of a definite development policy to the modernization of an old station. Port Washington is of interest because it was laid out in the days when the country as a whole was thinking in terms of $124 per kw., but will not cost more than half of this amount.

Though there has been little new construction in the Central Station field, the outlook for the industry as a whole is promising. Indeed, not since the beginning of the crash has the outlook been more hopeful. At recent meetings of the manufacturing and wholesaling groups reports from every side were to the effect that business is materially bettering and that there is renewed confidence. As tangible evidence of this improved state of business we may take the financial statements of the two foremost electrical manufacturing companies, the General Electric Co. and Westinghouse Electric & Mfg. Co. General Electric reported an increase of 27 per cent in the orders received during the first 9 months of this year over that of the same period in 1933. Westinghouse for the same period reported 49.4 per cent increase in orders. These reports are typical of many others.

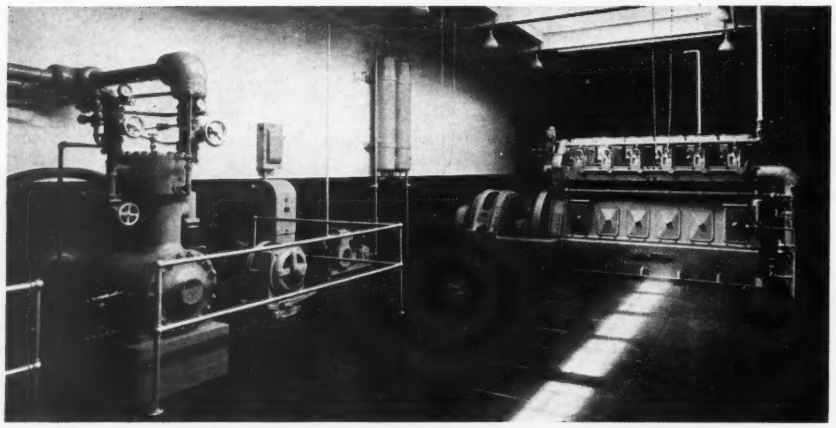
SLIGHTLY over a decade ago, the average good central station plant produced a kilowatt hour of electrical energy with a heat input of around 20,000 to 23,000 B.t.u. Today plants that will operate at 10,000 B.t.u. can be built in either of three types, steam, mercury vapor or Diesel. But though the heat rate has been cut in half we are not content to accept present practice as being perfect. Far seeing minds today are thinking in terms of new chemical cycles and heat rates of possibly 5000 B.t.u. per kw-hr. These matters are still far in the future but it speaks well for the condition of the industry that those engaged in it have this foresight.

Electrical Output Up

An analysis of the earnings reports of operating companies throughout the country also discloses a steady improvement over last year. This, of course, is reflected in the electric power output curve, which on the whole has remained steadily above that of 1933. Although we are writing in the beginning of November, the recent changes with respect to the output curve are distinctly favorable in contrast with those occurring at this time a year ago when the trend was definitely downward. The margin of increase over 1933 has been widening and at the time of this writing stands at 5.4 per cent.

In Canada the output of central stations also is materially up with respect to 1933, during recent months as much as 10 per cent. And in Great Britain, during the first nine months of 1934, the total amount of electricity generated was 10.8 billion units compared with 9.3 billion units for the corresponding period of 1933, an increase of 16.1 per cent.

Whether these statistics on energy output have any fundamental significance with respect to conditions



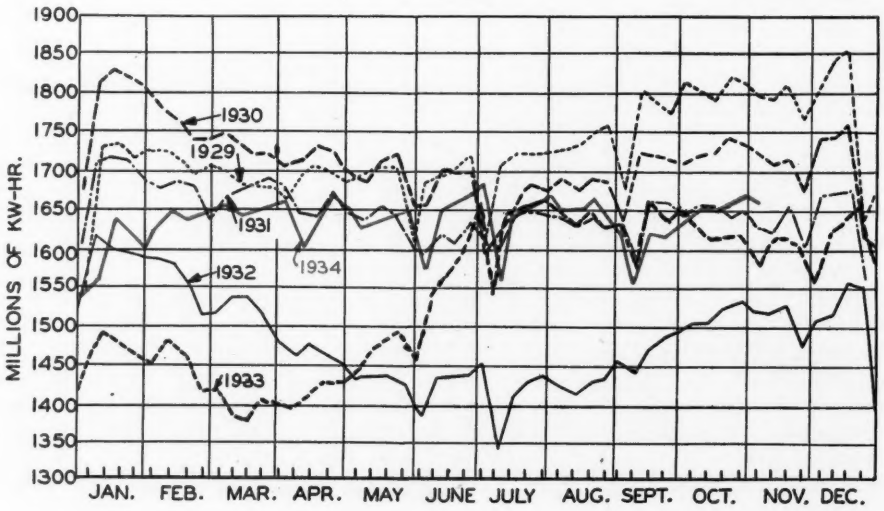
DIESEL ENGINES IN THE NEW PLANT OF THE OHIO WAX PAPER CO. AT COLUMBUS.

Two 4-cycle Diesel engines of the very latest design, one 250 br. hp. 6 cylinder direct connected to a 166 kw. generator and one 105 br. hp. 4 cylinder Diesel connected to a 110 kw. generator both with direct connected exciters. (Photo courtesy, Wiston Engine Corp.)

generally is a question which we will not enter into here, but the energy output has been a fairly reliable yardstick in recent years and there is no reason to believe that it is of less significance now. Measured by the electrical energy consumption, the decline started early in 1929 and struck bottom in the summer in 1932. Since that time recovery has been definite and much of the lost ground has been regained. As a matter of fact the total load is not far below the 1929-30 peak. Since the industrial load is still far below normal this means that the domestic load is responsible for the increase since the depression. Thus it makes one wonder what will happen should there be a considerable increase in industrial load—all marginal capacity would be wiped out in a short time.

Much is being done by operating companies everywhere to stimulate increase of domestic load. This year several companies tried the experiment of giving electricity away for a month or two months. The Milwaukee Electric Railway and Light Co. permitted residence, rural and commercial lighting customers to use an unlimited amount of electric service for the months of May and June at a cost no greater than the monthly meter reading in March. The San Joaquin Light & Power Corporation had a similar arrangement during the same months. In both of these experiments much was learned regarding the possible consumption of current among various classes of customers and resulted in considerable gain in good will towards the respective companies. In the case of the Wisconsin Company the power so distributed was to a large extent surplus power generated by hydroelectric plants in northern Wisconsin which, of course, reduced the cost of the experiment. The T.V.A. project is also being regarded with great interest by utility people the country over since one of the objectives of that project is the increased use of electrical energy by the consumer. Already it is having its effect and this year several manufacturing companies produced new low priced domestic refrigerators and ranges to fit in with the T.V.A. plan. These ranges and refrigerators sell for approximately half the cost of the previously available products.

The industrial load, as mentioned before, is still far below normal, due largely of course to the reduced manufacturing level of the capital goods industries but also, no doubt, to a greater appreciation on the part of manufacturing plant owners of the advantages of private plant operation. Detailed studies of the heat and power requirements in many manufacturing industries in recent years have indicated the desirability of private power generation. Where the steam requirements can be sufficiently synchronized with the electrical requirements, power in most instances can be



THE ELECTRIC POWER PRODUCTION CURVE FOR 1933.

Throughout the year the output of electricity has maintained and exceeded the levels to which it rose during the summer of 1933. Since the middle of September there has been a continual upward trend placing the output noticeably above the 1933 level in November.

supplied more cheaply by a private plant than by purchased power, because in a properly designed plant of this kind the condenser losses are eliminated. Each case, of course, requires careful study because there are many instances where because of peculiarities in the load requirements it will be found advantageous to use purchased power. With the development of higher pressure boilers and high back pressure turbines, and a more careful analysis of the power requirements, many new private plants have been installed recently. In view of this state of affairs, the utilities have become more receptive to the idea of a closer coöperation between industrial plants and central stations, and during the year several new applications of this idea were made. These are described elsewhere in this issue.

It is quite evident, then, from this brief discussion of the power industry, that it is in a state of flux and that readjustment is taking place in all branches of the field. This is a healthy condition and one which indicates that those engaged in the field are progressive and alive to every opportunity. As far as the central station and private plant are concerned, there is a greater recognition of the fact that it is not a case of one or the other—the survival of the fittest—but a case for coöperation and coördination in all respects, technical, commercial, and social. This is reflected particularly in recent European developments. One of the important events of the year was the completion of British Grid in April. This is claimed to be the first and far greatest example of concrete planning of a national utility service of any country in the world. As a matter of fact the element of coördination is perhaps the most vital element in the further progress of civilization and it is only by a more thorough appreciation of it that we can expect to go on from where we now find ourselves. Whether it be in the generation and distribution of power or in the solution of the unemployment problem, unless we can effect proper coördination of the various elements involved, we will be doomed to failure.

Reconstruction Finance Corporation Ready to Aid Industry

INDUSTRIAL CONCERNS, eligible to borrow funds from the Reconstruction Finance Corporation for the purpose of maintaining and increasing employment, can by provision of Congress get such loans, subject to the following requirements:

(1) That the business must have been established prior to January 1, 1934. (2) That such loans be adequately secured. (3) That maturity of loan must not exceed 5 yr. (4) That borrower must be solvent at the time of disbursement of the loan. (5) That credit at prevailing bank rates for loans of the character applied for be unavailable at banks. (6) That reasonable assurance of increased or continued employment of labor be given. (7) That the aggregate of such loans to any one borrower made directly or indirectly shall not exceed $500,000. (8) That such other provisions as the Reconstruction Finance Corporation may impose be complied with.

Directors of the Reconstruction Finance Corporation feel that these loans should be utilized as fully as possible for the advance of permanent business recovery, and that this objective can be accomplished best if the moneys loaned are used principally for the payment of labor and the purchase of materials incident to the normal operation of the business, though in exceptional cases a small part of the loan may be used for payment of existing debts or for improvements or repairs that do not materially increase capacity.

The Corporation will make loans in coöperation with banks, or by the purchase of participations in loans made by banks. In cases of national banks, only the bank's participation in such loans, rather than the full amount of the loan, must be within the legal limit which may be loaned to any one customer, and accordingly this plan will allow substantially greater credit to be extended through such channels to borrowers who are already borrowing up to their legal limit.

The Corporation suggests to industrial concerns, to which credit at prevailing bank rates for loans to continue operation is not available but which can offer adequate security (even though such security may be frozen and therefore not generally acceptable to banks) and which can profitably use additional funds for labor and materials, that they communicate with the local loan agency of this Corporation serving the territory in which such concerns are located. Each Loan Agency of the Corporation will, when requested, assist and advise with applicants in determining their eligibility and in the preparation of applications.

Air Cleanliness

AMOUNT AND NATURE of foreign material, such as dusts, smoke, fumes, gases, and disease-producing organisms in the air breathed determine its degree of purity, says the Metropolitan Life Ins. Co. in one of its industrial health series. In every city, the number of particles of dust per cubic foot of air surrounding city buildings may extend into the millions. While the nature of the dust encountered determines its harmfulness when inhaled or ingested, it must be remembered that dust also carries and spreads bacteria which may be the origin of many respiratory diseases.

A proportion of these substances may be removed from the air supply of buildings by means of a filtering medium or by directing the incoming air supply through an air washer.

In industry where dusts, fumes and toxic gases are generated in connection with plant processes, use should be made of localized hoods and exhausts for withdrawing these substances at their source of origin, thus preventing access to the general atmosphere of work places. Where elimination of these substances at their source is impracticable, exposed workers should be protected by means of a respirator effective in filtering the air before it is breathed, or by furnishing an uncontaminated air supply by means of positive pressure air masks.

MODERNIZATION *Dominates* Power Plant Development

Engineering Talent Concentrates on Low Cost Installations and Industrial Problems with Notable Success. Central Stations Improve Details But Shun Radical Developments

Fig. 1. Engine room, new Lillybrook Coal Co. plant showing one of 2—750 kv-a. engine driven generators. (Photo, courtesy Skinner Eng. Co.)

FOR SOME TIME PAST the limits of the present regenerative cycle have been closely approached and it has been apparent that any definite advance beyond this must be by means of binary vapor cycles or some chemical cycle. Binary vapor cycles have been proven successful with mercury vapor although at a cost which deters further expansion at this time. Other binary vapor cycles are being intensively investigated and it has been rumored that new chemical cycles now under experiment will cut the present heat rate in half. This, however, remains to be seen and proven.

Although this momentary halt has been due to a combination of circumstances in which engineering plays a part, the main causes are economic, political and social. Normally the bulk of the development work is carried on by the utilities or utilities working with the equipment manufacturers. In the face of drastically reduced incomes, over capacity and a definitely antagonistic administration policy, development work by the utilities has lagged.

What development there has been, is, perhaps fortunately, largely on paper for in the Depression Arena, Economics was badly punctured and, considerably collapsed, is now being led through the nose by the new champion—First Cost. Previous costs of $100 to $125 per kilowatt of capacity must now be cut to half of that and it is hard to predict what type of station this might beget if additional capacities were imperative at present. Building to a price, rather than building for a service, has never been a substantial business foundation although it can apparently be justified and is sometimes resorted to in an emergency.

Whether the present emergency justifies such drastic cuts in costs that proper instrumentation, automatic control and regulation, which made possible the operating records and large interconnection systems, is questionable. Certainly an emergency does exist. Politically the utilities have been fair game for anyone and a target for misplaced patriotism. Uncertainty regarding the final outcome of the various Federal hydro-electric projects, scheduled to take considerable load from the utility systems; open encouragement to municipal systems through P.W.A. loans; uncertainty regarding extended authority of the Federal Power Commission and the shortage of capital all combine to make the future uncertain.

Money for new plant construction, ordinarily realized from stock or bond issues, is scarce due largely to the fact that business men, both utility and industrial, feel that certain requests of the Federal Securities Act are unreasonable. This one factor in itself has been sufficient to place undue emphasis on low first costs. Few utility systems in the country are in a position to overlook the need for additional capacity much longer and must be in a position to meet the demand when it comes up.

Practically no new capacity has been added for several years and during this period the domestic load has increased by leaps and bounds. In spite of the fact that the industrial load is far below normal, the total load is not far below the 1929-30 peak so that any considerable increase in industrial load will wipe out the marginal capacity.

It is possible that the above conditions will force a change in constructional policies. In the past base load stations have predominated and the large systems at least are well supplied with base load plants, modern and with a reasonably good heat rate. Uncertainty and scarcity of money may make it desirable to build peak

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Fig. 2. 600 lb. 825 Deg. F. rebuilt turbo-generator at Connors Creek Station. (Photo, courtesy Detroit Edison Co.)

load plants in the immediate future, simple plants with a high salvage value, quickly erected and with a low first cost. Recent high temperature developments have made such a plant quite practical.

The above conditions have had little influence on the three central stations now under construction except perhaps to slow up construction somewhat. If the load had not dropped they would have been completed last year, so that for all practical purposes the designs were unaffected by current conditions. Of these three the Connors Creek Station of the Detroit Edison Co., now practically completed, is perhaps of most widespread interest because it represents the application of the results of a definite development policy to the modernization of an old station. In spite of a country-wide intensive high pressure development, this company stuck to a moderate pressure when building Delray No. 3, but immediately embarked on an experimental high pressure investigation which culminated in the installation of a 10,000 kw. 400 lb., 1000 deg. F. turbine.

High Temperatures

Operation over a considerable period proved 1000 deg. F. to be feasible and tests showed that the energy consumption of the complete unit, i.e., turbo-generator and three heaters, was 10,730 deg. F. at rated load and an exhaust pressure of 1 in. absolute. This represents a thermal efficiency of 31.8 per cent and an engine efficiency of 76 per cent. It was also found that increasing the steam temperature from 700 to 1000 deg. F. reduced the energy consumption 920 B.t.u. per kw-hr., or about 7.9 per cent.

In spite of this successful operation and performance it is significant that Connors Creek Station is being rebuilt for 850 deg. F., perhaps another concession to the demands of first cost. Connors Creek, built just before the War, had 20,000 and 30,000 kw. units operating at 225 lb., 585 deg. F. The boilers were 2365 hp., double, bent tube type fired by double opposed stokers.

The rebuilt station will operate at 600 lb., 825 deg. F. and will have three 30,000 kw. generating units with four stages of regenerative heating. Two of the new generating units are rebuilt, using parts of old turbines, two old 30,000 kw. generators and old 32,000 sq. ft. condensers. Steam will be supplied by four new stoker fired boilers of the same type as the old ones but with a much greater steam capacity for the same ground area. Superheaters will be of the compensated unbalanced type recently developed for this type of boiler at Trenton Channel. The change in steam conditions involved complete replacement of steam and feedwater piping. The new piping system will be completely welded, using welded end type valves.

On October 29 the drying out fire was lighted in the first of the four new boilers, and on November 2, the throttle of the rebuilt 30,000 kw. turbo-generator was opened and the machine turned over for the first time. These are the first of the units of three turbines and four boilers which will replace three 20,000 kw. turbines and four of the original 200 lb., 600 deg. F. boilers whose steaming rate was 150,000 lb. per hr. Each of the four new boilers will have a normal steaming capacity of 330,000 lb. per hr. which will be more than enough steam for one of the 30,000 kw. turbines at full load.

This first turbine, now known as Number 8, was rebuilt from the 30,000 kw., 200 lb., 600 deg. F. machine formerly known as Number 10 in Delray Power House Number 2, which first saw service on January 31, 1920. The generator end is practically unchanged but of course it has been necessary to rebuild the turbine end for the higher temperature and pressure and for the four stages of bleeding. The second turbine, which will be called Number 9, is being rebuilt from the old 30,000 kw. Unit Number 8 at Connors Creek. It originally went into service on June 11, 1920. This unit with its corresponding boiler will be ready for service

early in 1935. The third turbine is practically a new machine. It will be ready for service along with the third and fourth boilers in the fall of 1935. The turbines are mounted on the same bases as were used under the original 20,000 kw. units and the old exhaust hoods and condensers with their auxiliaries are being used for the three new units.

One new D.C. 2,000 kilowatt auxiliary turbine now in the process of erection will go into service at about the same time as the main unit. The boiler feed pumps for the new units deliver feedwater at approximately 1,000 lb. pressure and will be driven by A.C. adjustable speed motors instead of by D.C. motors, which have been used in other Detroit Edison installations. This change was made to permit the use of higher speed pumps than would have been possible with D.C. equipment.

GENERATION and distribution of electric power is now definitely established as one of the major factors of our civilization, a factor of such sociological and political importance to the nation that the financial and economic control responsible for its growth may in the future be forced back to positions of secondary importance. The work of the engineer must go on, however, perfecting the present power generation cycles and developing new ones. Today the three most efficient and important fuel-power conversion cycles are the reheat, the mercury-steam and the Diesel engine cycle, all three of which could today be made to reach the plane of approximately 10,000 B.t.u. per kw-hr. which closely approaches the lower theoretical limit of known cycles. The industrial plant has not been far behind the central station in accepting new developments and by combining power generation with process work are able to eliminate or greatly reduce the condenser loss with a corresponding increase in efficiency. Today we are at the cross-roads with no inkling of which road Fate will have us follow into the future.

At Richmond Station of the Philadelphia Electric Co., one of the best known and certainly one of the most beautiful of America's power plants, a new unit is being added. The boilers are now under construction and the turbine erection will be started in January, 1935. The entire unit will be in operation in the fall of 1935.

The turbo-generator is now being built by Westinghouse Electric & Manufacturing Company and has a generator capacity of 165,000 kw. at 90 per cent power factor. It is 3-phase, 60-cycle, 1800 r.p.m. unit and is air-cooled. The turbine is designed for steam conditions of 400 lb. ga. and 850 deg. F. total temperature at the throttle the same pressure but as increase of about 150 deg. F. over the original section. A Westinghouse 113,000 sq. ft. single-pass condenser is bolted directly to the turbine exhaust nozzle and is supported by counterweights.

At present the unit will be boilered for only 135,000 kw. of its total capacity and the steam supplied from two 600,000 lb. B. & W. boilers. These boilers are cross-drum, pulverized fuel fired units with slag tap furnaces. The walls and floors of the furnaces are entirely water-cooled. The boiler gases are cooled by Ljungstrom preheaters, after which they pass through Cottrell precipitators where a large percentage of the flue dust is removed. The pulverizing system is a semi-bin type, where sufficient pulverized fuel is stored for about 5 hr. maximum boiler operation.

Port Washington

The only really new station now under construction is the Port Washington Station of the Milwaukee Electric Railway & Light Co., scheduled for completion next year. This station represents the results of the most extensive pioneering and development campaign yet carried out in this country. A development which began with the pulverized coal experiments at Oneida Street Station in 1918. These were continued at Lakeside Station, built in 1920, and later merged with the development of 1400 lb. pressure and the radiant superheater and reheater. Port Washington is the final result of this development and although laid out in the days when the country as a whole was thinking in terms of $125 per kw. of capacity, it will not cost more than half that.

This will be a thoroughly ultra-modern station with an initial capacity of 80,000 kw. in one unit operating at 1390 lb., 850 deg. F. on the reheat-regenerative cycle. Pulverized coal will be burned using a modified bin system with flue gas drying of the coal in the mill. The layout is similar to a unit mill arrangement but comparatively small pulverized coal bins are used between the mills and burners. The boiler is of the bent tube type as developed at Lakeside and will have a combination superheater and radiant reheater giving practically automatic control of superheat and reheat temperature with an extremely simple arrangement. Operation at Lakeside over a period of years has shown that a boiler unit of this type has as high an operating factor as the turbo-generator. Therefore but one boiler unit, capable of carrying the full load of 80,000 kw. will be installed. The turbo-generator is of the tandem compound type and the reheat steam will leave and enter in the middle of the high pressure cylinder instead of between cylinders as is customary.

End of a Definite Era

It is difficult to look at the past year as marking off a definite advance. Rather it is the beginning of the end of a definite power plant era beginning about 1920-4. This period brought about the definite establishment of pulverized fuel and the regenerative cycle. In addition it saw the rapid development of the reheat cycle and its still more rapid eclipse by high temperature; the possibility of million pound boilers; of 160,000 kw. single shaft turbo-generators; of giant underfeed stokers; of critical pressure boilers; of the mercury cycle; of 1100 deg. F. superheaters; of 100,000 sq. ft. condensers and a score of minor developments.

In other words, the stage is set for building a 10,000 B.t.u. per kw-hr. plant of any one of three types: Diesel engine; high temperature-reheat, or Mercury

vapor and steam. As far as heat rates are concerned the three may be made practically equal although there is still considerable difference in first cost. The Diesel has the advantage of high efficiency for small and medium sized plants; the mercury plant has many advantages for industrial plants and by-product power generation, while the high temperature reheat station is fundamentally a central station plant. Probably

consists of a 1400 lb., 760 deg. F. boiler and a 10,000 kw. turbine exhausting at 230-260 lb. to an evaporator. The boiler, by the way, has the largest fusion welded drum yet made, 54 in. I.D., 4 in. thick and 23 ft. long which is, of course, small compared with the largest forged drums recently completed for the Port Washington Station. Two of these forged drums were 62 ft. long, 40 in. I.D. and 5¼ in. thick.

Tabulated data on a few of the industrial and municipal power plants put into service during the past year. Some of these plants are new, some rebuilt but they all show the influence of modern equipment and good sound engineering.

	BOILERS									TURBINES					
PLANT	NO.	SIZE SQ. FT.	PRESSURE LB. PER SQ.IN.	TEMP. DEG. F.	ECON. SQ. FT.	AIR HTR. SQ. FT.	TYPE	FIRING EQUIPMT.	DRAFT EQUIPMENT FAN C.F.M	TYPE	NO.	SIZE KW.	SPEED R.P.M.	VOLTAGE	CONDENSER SQ. FT
AMERICAN BOX BOARD	—	——	——	——	——	——	——	——	——	COND. BLEEDER	1	3000	3600		1950
NEWTON	2	2502	250	550	——	——	BENT-TUBE	P. COAL	——	COND.	3	600 HP 775 HP 1000 HP	6000/1200	4000	
TAUTON	1	10,293	500	725	——	9980	BENT-TUBE	OIL	F.D. 28,000 —8" I.D. 48,000 —1"	COND. BLEEDER	1	7500	3600	13,800	8500
CLINTON COTTON MILLS	2	4673	400	725	——	——	BENT-TUBE	P. COAL	F.D 40,000-6½"	EXTRACT COND	1 1	5000 1000	3600	2400	6400 1295
INDUSTRIAL COTTON MILLS	3	3561	300	571	——	——	BENT-TUBE	P. COAL	F.D 28,000	EXTRACT. COND	1	2000	3600		2750
PACIFIC MILLS	2	7682	175	——	——	——	BENT-TUBE	STOKER	F.D. 70,000-5 ½"	——	—	——	——	——	——
SHELBY COTTON MILLS	2	3258	250	505	——	——	BENT-TUBE	STOKER	F.D FAN	EXTRACT. COND	1	1000	3600		1440
SHELBY	2	45,000 LB. PER HR.	250	650				STOKER		COND.	1	1500	3600		
JEDDO HIGHLAND	2	7028	450	575	——	——	BENT-TUBE	CH. GRATE		COND. EXTRACT	1 1	1250 1000	3600 3600	2300	
COLGATE-PALMOLIVE-PEET	1	4100	425	575	——	——	BENT-TUBE	CH.-GRATE	F.D. 15,000-3 ¼" I.D. 23,000-3"	B.P.	1	500	4650/1200	480	——
HERSHEY	4	11,200	450	650		19,300	BENT-TUBE	P. COAL	F.D. 53,000 I.D. 96,500	EXTRACT COND.	1 1	6000 7500	3600		
LOGAN LONG	1	5900	300	425	——	——	BENT-TUBE	STOKER		——	—	——	——	——	——
AMERICAN CHICLE	—	——	——	——	——	——	——	——	——	COND. & B.P. & EXTR	4	300 TO 187 KV-A.		7200	1-785
ENDICOTT JOHNSON	1	8070	250	510			BENT-TUBE	P. COAL		——	—	——	——	——	——
WILSON	3	11,220	380	550	4830	13,788	BENT-TUBE	P. COAL	F.D 49,000 I.D. 70,400	EXTRACT. B.P.	3	3124 KVA 2500 KVA 1875 KVA	3600	480	——
GOODYEAR	1	20,131	800	750	——	33,400	STR-TUBE	P. COAL	F.D. 2-78,000-2.5" I.D. 1-180,000-10.25"	B.P. EXTRACT	1	7500	3600		——
FREEPORT	6	8800	225	400			BENT-TUBE	OIL	I.D. 3 147,000		3	750			
WASHINGTON HEATING	6	25,243	400	SAT.	——	——	STR-TUBE	STOKER		B.P.	2	1000			
FIELD BLDG.	2 2	9000 2500	100	SAT.	——	——	BENT-TUBE	CH-GRATE OIL	——	——	—	——	——	——	——
ONE MAN	1		200	SAT.	——	——	BENT-TUBE	OIL	——	ENGINE	1	175			——
TIDEWATER	3	8727	713	758	6698	——	BENT-TUBE	OIL	——	1-B.P. 1-COND.	2	3375	3600	2400	
FORSTMANN	2	6520	450	610	——	6650	BENT-TUBE	P. COAL	F.D. 28,500-7.7" I.D. 55,000-7.2"	EXTRACT. COND.	2	2000	3600	500	1290
WYANDOTTE	2	6200	450	700	——	TUBULAR	BENT-TUBE	STOKER	F.D. 22,500-9" I.D. 44,500-1"	COND.	1	3000		2300	
WALKER	2	13,790	250	510	——	14,500	BENT-TUBE	P. COAL	F.D. 175,000-8" I.D. 230,000-6.5"	EXTRACT B.P.	2	1500	3600	480	——
HOPPER PAPER	2	4005	200	500	——	——	BENT-TUBE	CH-GRATE		ENGINES	3	2-400 1-100		2300	——
CONTINENTAL	1	6680	262	SAT	——	6600	BENT-TUBE	P. COAL	F.D. 31,000-6.3" I.D. 52,500-7"	——	—	——	——	——	——
FROEDLERT	2	2540	200	SAT.	——	AIR COOLED WALLS	BENT-TUBE	P. COAL		——	—	——	——	——	——
CENTURY	4	5000	150	475	——	——	BENT-TUBE	CH-GRATE	F.D 15,000	EXT. B.P. EXT. COND.		625 750	3600	480	——

Port Washington will remain the foremost example of this type of plant for several years or until the steam temperature gradually approaches the 1000 deg. F. mark and again brings the reheat cycle from its temporary retirement.

Probably Buzzard Point Station, put into service late last year and completed this year, will remain the high point of conventional straight regenerative cycle for some time. With three stages of extraction this station is reported to reach a heat economy of 12,200 B.t.u. per kw. net. The plant operates at 685 lb., 835 deg. F. as shown in the heat balance, Fig. 2, and is probably the type of plant that, without some of the refinements, will prove popular during the next few years.

Of course in any steam plant devoted to power generation the condenser loss is largely responsible for the low efficiency. So far the only known method of eliminating this loss is by raising the exhaust pressure of the prime mover and using the steam for heating and process. The most striking example of this is the new high pressure plant now under construction by the Firestone Tire & Rubber Co. at Akron, O. This

Utilization of this exhaust steam for the purpose of increasing efficiency has been the dream of engineers for many years. Many industrial plants have been remarkably successful, some of the outstanding ones being Champion Coated Paper; Waldorf Paper and Decker Packing. Most industrial plants have difficulty in correlating the electric and steam loads, however, and for some time past it has been recognized that the only practical general solution of the problem is closer co-operation between industrial plants and central stations.

The past year has seen two signally successful applications of this principal, the new Hiram Walker Distillery at Peoria, and the Taunton, Mass. municipal plant. The Walker power plant consists of two 180,000 lb. per hr. pulverized coal or gas fired boilers operating at 250 lb. 110 deg. F. superheat. These boilers supply steam for process through two 1500 kw. extraction turbines operating against a back pressure of 15 lb. ga. The generators are paralleled with the public service system and the plant operates on a power interchange agreement.

At Taunton, a 7500 kw. addition to the station was

made this year at a total cost of $320,000 or for $42.65 per kw. of capacity. The turbine operates at 425 lb. ga., 125 deg. F. Extraction steam will be sold to a group of fourteen industrial plants within about a half mile radius of the station. Maximum extraction demands will be about 50 per cent and will decrease the heat rate to about 10,000 B.t.u. per kw-hr. Full condensing the heat rate will be between 15,000 and 16,000 B.t.u. This is, of course, somewhat below that of larger modern central stations but it must be remembered that the fixed charges or $43 per kw. station range from a third to a half of the fixed charges in the usual station. This saving of from 2 to 6 mills per kw-hr. in fixed charges is expected to more than offset the 0.5 to 0.75 mill increase in fuel charges under full condensing operation. Even without the unusual factor of industrial co-operation the station is worthy of attention as one of the most economical yet built.

Springfield Water Works

Under the impetus of P.W.A. loans and grants many new municipal water works power plants are planned and a number are under construction, many of these being built wholly or partially by P.W.A. money. Probably the most noteworthy one that will set a new standard of architectural treatment is the new water works power plant at Springfield, Ill. The initial section now nearing completion will consist of one 110,000 lb. per hr. boiler and one turbo-generator.

Another pumping station, that of Newton, Mass., was recently modernized by installing two 2500 sq. ft. pulverized coal fired boilers and three turbine pumping units, consisting of a turbine reduction gear, a.c. generator, d.c. generator and two centrifugal pumps all on the same shaft. Shelby, O. completed the installation of a 1500 kw. unit and Fort Wayne, Ind. a 10,000 kw. unit while Wyandotte, Mich. put into service a 3000 kw. plant that had been under construction for some time.

In the industrial field, modernization of power facilities is each year playing an increasingly important role. Keen commercial competition has thrown a searchlight on power service costs which, in the absence of central station construction, has attracted the concerted attention of engineers and manufacturers. As a result a much broader experience has been brought to bear on the industrial problem and closer coöperation between isolated and utility systems on a firmer economic foundation has resulted.

High pressure has been firmly established in the industrial field and the boiler capacity to be added next year for the second 110,000 kw. Ford unit will bring the total 1200 lb. boiler capacity of that plant up to 2,200,000 lb. per hr. More representative of industrial practice, however, are the two rubber industries plants at Akron, O. The Goodyear, 745 lb., 740 deg. F., B. & W. pulverized coal fired boiler and slag-tap furnace marks a notable advance in industrial boiler design. The 300,000 lb. per hr. of steam will be used in a 7500 kw. G. E. turbine exhausting at 100 lb. and bled at 200 lb. The new Firestone plant has a 1400 lb. Combustion boiler and a 10,000 kw. G. E. non-extraction turbine exhausting at 230-260 lb. to an evaporator.

In the packing industry, the Wilson plant has created a great deal of interest. The new section of the plant consists of three 380 lb. ga., 550 deg. F., 11,220 sq. ft. Combustion boilers fired by pulverized coal. Steam from these boilers is supplied to three G. E. non-condensing turbo-generators which are bled at 155 lb. for the old engines and turbine drives, at 80 lb. for process and exhaust at 10 lb. for process and heating.

By Product Power

Superimposing a high pressure unit on an old plant in this way can be done with little change in the existing equipment although in many cases it is advisable to rebuild the plant for high pressure utilizing only a portion of the old equipment. The Tidewater Refinery for instance generates about 4500 kw. of by-product power in a new plant. This consists of three 100,000 lb. per hr., 715 lb., B. & W. oil fired boilers supplying steam to two 3375-kw., G. E. turbines. These units exhausting at 150 lb. to the refinery mains which connect with two other 150 lb. plants and a generating station having two 150 lb. turbo-generators, one 3750 kv-a. mixed pressure and one 3750 kv-a. straight condensing.

At the Hershey plant the pressure was doubled by adding three 450 lb., 650 deg. F. Edge Moor boilers with a capacity of 150,000 lb. per hr. each and converting one 6000 kw. and one 7500 kw. turbine for high pressure. The high pressure system was tied into the old system so as to supply steam for the turbines and refrigerating machines that could not be converted. The Colgate-Palmolive-Peet plant has also been rebuilt in this same pressure range, that is 425 lb., 575 deg. F. One 4100 sq. ft. Combustion boiler and a Terry turbine geared to a 500 kw. a.c. generator has been added. The turbine exhausts at 100 lb. to process and it is expected that after certain factory changes have been completed a 100 lb. condensing unit will be added.

Coal Mine Electrifies

Even coal mines have been convinced of the advantages of modern high pressure equipment, the new Jeddo-Highland plant replacing several older and obsolete plants on their several properties. The plant consists of two 7026 sq. ft., 450 lb., 575 deg. F. Combustion boilers and a 1250 kw. G. E. condensing turbine bleeding at 160 lb. and operating in parallel with the utility system. A 160 lb. condensing unit bleeding at 5 lb. can be operated from either the old or new boilers and acts as a standby unit.

Of course, not all modernization projects are high pressure, the Hopper Paper plant for instance, consisting of two 4005 sq. ft., 200 lb., B. & W. boilers and three Skinner Engines, two 400 and one 100 kw., has already shown a comfortable saving of some $31,000 a year. The American Box Board by modernizing its production end and adding a 3000 kw. Westinghouse bleeder condensing unit have cut out one 350 hp. boiler and still have two spares, due to the reduction in steam demand. American Chicle added four De Laval turbine units for by-product power generation with a handsome return. These consist of a flexible combination; one 500 kv-a. condensing unit, one 500 kv-a. non-condensing bleeder, one 312 kv-a. and one 187 kv-a. back pressure unit.

Boiler rooms are perhaps the most fertile field for improvement, however, for the saving in space as well as in fuel. Endicott Johnson replaced six old boiler units with one 8078 sq. ft., 250 lb., 510 deg. F. Erie City pulverized fuel fired boiler with a capacity of 72,000 lb. per hr. As the first unit of a new high pressure plant Logan Long installed one 5900 sq. ft. 300 lb. Foster Wheeler stoker fired unit which will be operated temporarily at 150 lb. pressure. The Froedlert Grain & Malting Co. added two 254 hp. 200 lb. Wickes boilers fired by Whiting pulverizers and saved $12,797 in a year despite increased labor costs.

As might be expected, distilleries were extremely active during the past year. One of these, the Hiram Walker plant, has been mentioned earlier. Another excellent example of a modern flexible low pressure plant is the Century Distilling where four 500 hp., 150 lb., 475 deg. F., B. & W. boilers and 1375 kw. in two a.c. generating units in condensing and non-condensing operation are installed. As a rule distilleries are largely steam driven and the boiler room is the main consideration, although even then provision for future power generation is considered advisable. An excellent example of this is the Continental Distillery where a 6680 sq. ft., 262 lb. Riley pulverized coal fired unit was installed to be operated temporarily at 150 lb. pressure.

As in past years the textile industry is well represented in the list of notable plants for the year. Of the six listed, three, Forstmann, Proximity and Clinton, use pulverized coal and three, Pacific, Industrial and Shelby, use Taylor underfeed stoker. The most extensive brewery development was that of the Hamm Brewing Co. which installed three 4750 sq. ft., 300 lb., 600 deg. F. Bros low headroom boilers fired by Detroit stokers and two 1250 kw. G. E. turbines bleeding at 60 lb. and exhausting to Worthington condensers.

In the large cities office buildings and apartment houses have entirely different problems to face. Steam and power are as a rule both available at reasonable prices making the economics of the power services more complicated. The new Field Building in Chicago is an excellent example of office building service facilities. Here two 500-hp. chain grate fired and two 250-hp. oil fired B. & W. boilers are installed and provision made for the use of natural gas or central district steam as occasion demands in the future. No generating equipment has been installed but space is available if this should become advisable in the future.

In New York two of the so-called "One Man Plants" have been installed in apartment hotels. These consist primarily of a simple arrangement of one Erie City boiler and one Ames engine unit with central station current as standby. The arrangement was made possible by a special ruling of the Public Utility Commission sanctioning the use of an automatic synchronizing panel which in case of a change over parallels the generating unit with the utility system for an instant so that there is no interruption of current to cause lamp flicker or to stop the electric clocks.

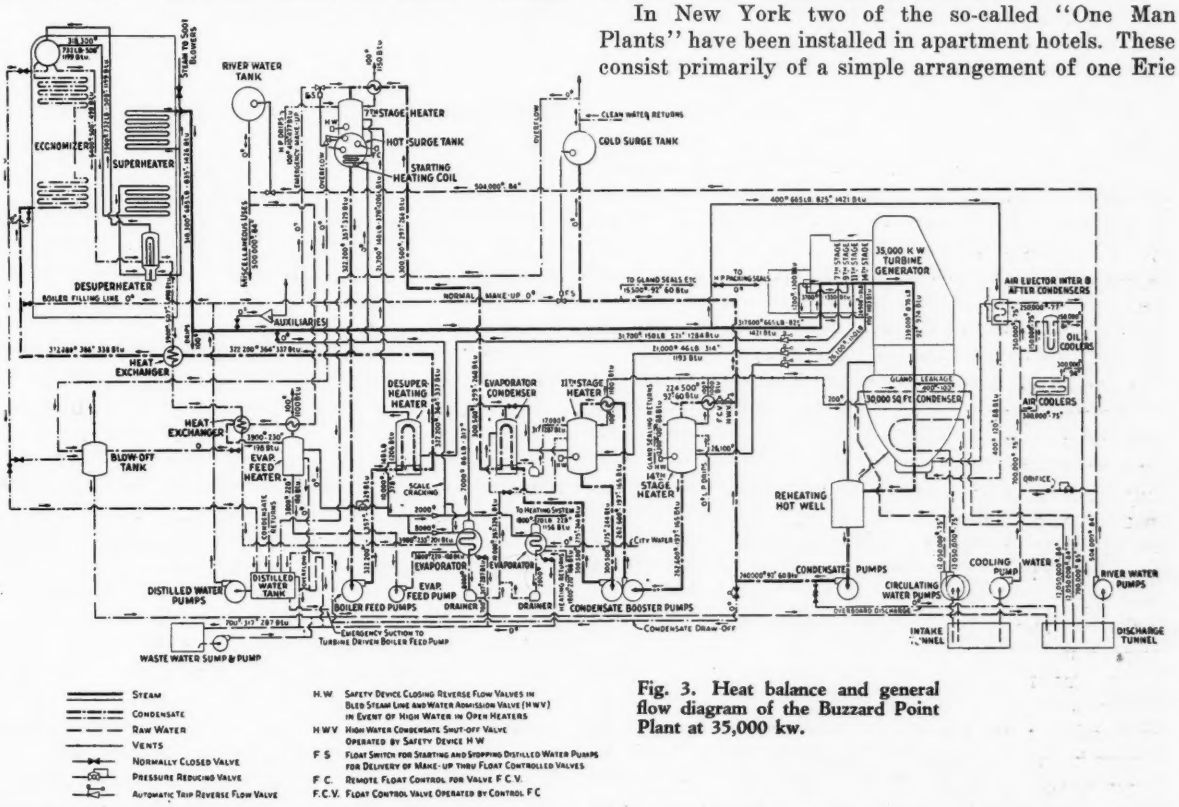


Fig. 3. Heat balance and general flow diagram of the Buzzard Point Plant at 35,000 kw.

In many metropolitan districts industrial steam is available for purchase either from nearby central stations or industrial plants or central district systems. This may be at high or low pressure depending upon the location. In several cases high pressure steam has been purchased and used for turbine operation. A recent installation of this kind is at the Hygrade Food Products Corp., in Chicago, where a 200 kw. back pressure unit has been added to "skim off" the by-product power from the 200 lb., 150 deg. F. superheat steam purchased for process work in the packing house.

DETAILED IMPROVEMENTS *Characterize Equipment for* Steam Generation

MODERNIZATION programs in power plants have demanded new equipment in old housings which working in conjunction with old equipment has resulted in the evolution of new designs and operating practices in the boiler house.

DEVELOPMENTS in boiler plant equipment during the past year may best be summarized by stating that designers have made special efforts to improve not only the boiler units themselves but the accessories, instruments and combustion equipment, all of which go to make up a reliable and efficient boiler plant. While some boilers with new features of design have appeared it is quite evident that most designers find the answer to their problems in the conventional designs of previous years.

Nearly all of the power plants that have gone into service during the past year are in the industrial class and are the result of a modernization program found necessary to meet increasing load and competition conditions. Thus we find many new boilers with modern features replacing old with obsolete accessory equipment. Higher steam pressures and temperatures have almost invariably been adopted in these plants, in some cases a two-pressure system being adopted in order to make use of machinery still in use which could not withstand the higher pressures.

In all new and modernized plants, a decided tendency toward the use of more instruments and automatic control devices is noted than has been the case in former years. There are unquestionably several reasons for this, among the most prominent of which are: higher over-all operating economy possible, improved safety to employes and equipment, more dependable and accurate instruments available, and a better understanding of instruments and their uses by the operators.

Little change is noted in the kind of fuel burned although in some sections of the country natural gas has been made available by the building of transmission pipe lines, and plants in these localities are taking advantage of this fuel where it is thought to be the most satisfactory.

Boiler Design and Construction Features

One of the outstanding designs of the year is the integral furnace boiler installed in the plant of Clinton Cotton Mills. This type of boiler is the product of the Babcock & Wilcox Co. and its flexibility makes it particularly adaptable for industrial service. The two drums are connected by inclined tubes which form the boiler proper and are separated from the furnace by a water-cooled wall. The other walls and floor of the furnace are also water cooled. The boiler tubes are arranged in three passes, i.e., the furnace gases enter the first pass shown together with the superheater at the rear of the illustration, are deflected by vertical baffles through the second and third passes in succession, taking a horizontal S path through the tubes. The arrangement of furnace and drums permits location in rooms with low head room, a distinct advantage when replacing many old boiler units. With slight changes, the furnace may be adapted to any type of stoker, pulverized fuel, oil or gas burner.

One of the distinctive features of the Riley boiler installed in the Forstmann Woolen Co.'s plant is the design of the water cooled furnace walls which are of the single plane design with the tubes entirely within the setting limits, an arrangement that does away with outside piping, is claimed to improve circulation, and simplifies insulation problems. This type of furnace is adaptable to all types of fuel burning equipment.

An improvement in detail of construction of its water tube boilers with straight tubes has been reported by Henry Vogt Machine Co., which consists of a new forging process enabling the forming of sectional headers from seamless steel tubing worked at high temperature. They are of the vertical type with tube faces inclined at approximately 15 deg. into which the tubes are expanded. These headers nest together and the holes are so located as to give a staggered arrangement to the tubes. Opposite each tube is a clean-out hand hole fitted with drop forged steel cover plate and crab with nut and gasket which gives immediate access to each tube for cleaning, inspection or rerolling.

One of the modifications in furnace design which

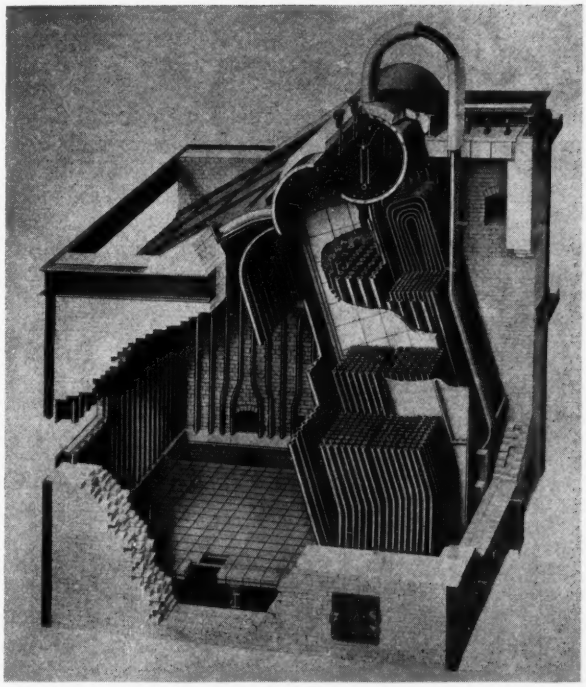


Fig. 1. Two-drum, integral furnace type boiler adaptable for industrial service

has appeared during the past year is the elimination of the front arch over forced draft traveling grate stokers and the provision of an extended rear arch protected by a bent tube water wall. Combustion Engineering Co. reports that this design gives improved operating results over former designs, the effects being quicker ignition, less combustible in ash and more thorough mixing of furnace gases with resultant better combustion.

For high pressure boilers, both welded and forged drums are being recognized as preferable to riveted drums and boiler manufacturers report that the percentage of welded boilers sold is rapidly increasing. Confidence in this type of joint was greatly increased with the development of adequate X-ray inspection methods and the recognition given this construction a few years ago by the Boiler Code Committee of the A.S.M.E. The welding process is also being used more frequently in repair work on boilers but casualty insurance companies still consider fusion welding too little understood to permit its general use and insist on enforcing that provision of the code which says that "no welding repairs shall be made before an inspection has been made by an authorized inspector and this method of repair sanctioned by him."

To perform a particular industrial service where an unvarying temperature is required, an experimental boiler was built by Combustion Engineering Co., which consists of a single row of tubes entering top and bottom headers connected by a single down-comer. The headers of forged steel are rectangular in cross section and placed on 7 ft. 2 in. centers, the tubes being 1 in. in diameter and the total heating surface is slightly over 9 sq. ft. A gas fired, refractory furnace is employed and saturated steam is delivered at 1500 lb. pressure, 575 deg. F. temperature. If this experimental boiler gives satisfactory results a full size boiler will be built to supply the steam on a manufacturing basis.

One of the most novel installations of the year is the group of General Electric Co. domestic oil furnaces that supplies the steam for heating the buildings at Mt. Holyoke College, South Hadley, Mass. In the main heating plant is a battery of 24 groups of 5 furnaces each, while 50 other furnaces are installed in isolated buildings. By means of thermostatic control, only the required number of furnaces necessary to maintain the desired heat will be operated at one time.

During the past year several electric steam boilers have been made available for industrial use, their advantageous application being in industrial processes where steam is wanted in limited quantities. Power ratings are of the order of 250 kw. with pressures carried at 100 to 200 lb.

From abroad it is learned that the Velox boiler has undergone changes which have converted it from an explosion type to one using constant pressure for fuel and air supply. Advantages of this type boiler are stated to be high efficiency over a wide range of load and economy of space occupied. Steam is generated by circulating water at high velocity through evaporating tubes, then through a separator. The tubes are of small diameter and inclosed in fire tubes.

On the gas side, combustion takes place in the combustion chamber under a pressure of about 35 lb. per sq. in. and results in high velocity of the gases. From the combustion chamber the gases pass at high velocity through the steam generator, then the superheater and on to the gas turbine which they enter at a temperature of about 900 deg. F. and little drop in pressure from the furnace. Gases leave the turbine at about 16 lb. pressure and pass on to the economizer. Energy generated by the turbine drives a direct-coupled air compressor which supplies air to the combustion chamber of the steam generator.

In the steam generator, the rate of heat transfer is high. As an example, in one case a 50,000 lb. boiler was brought up to full pressure of 240 lb. per sq. in.

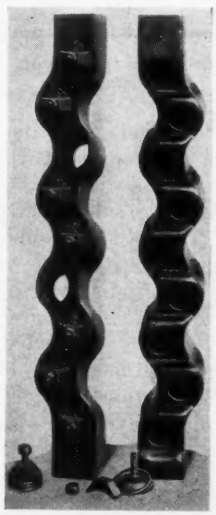


Fig. 2. Front and rear views of sectional headers forged from seamless steel tubing

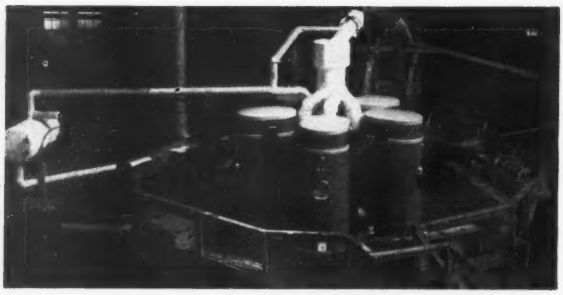


Fig. 3. Nest of oil burning boilers under test later installed at Mt. Holyoke College

in less than 5 min., and the automatic governing systems will respond to load changes from half to full load in 20 sec., while test results show thermal efficiencies of 90 per cent exclusive of the feed pump. The limiting factor in the use of this boiler is apparently the fuel which at present must be either liquid or gaseous.

In Germany, designers of the La Mont boiler are giving considerable attention to the provision of forced circulations of water in the boiler. The object of con-

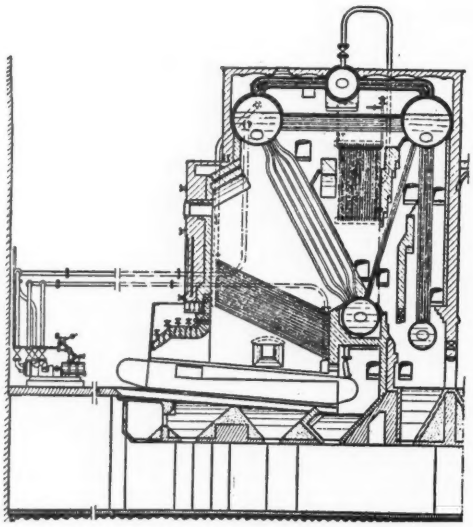


Fig. 4. Forced boiler water circulation is employed in this foreign boiler

trolling water distribution in the tube system by means of special nozzles is to prevent water flowing only through the less intensely heated tubes, which offer less resistance than the tubes which are exposed to the hottest gases. The La Mont boiler is provided with a boiler water circulating pump which is a simple, single-stage, centrifugal pump working against a head of about 35 lb. and requiring from 0.5 to 0.8 per cent of the steam produced by the boiler.

Some experimenting has been done abroad with variable pressure operation of the Benson boiler. In the past steam boilers have been operated at constant pressure, the variation in load on the turbine served being taken care of by the operation of the turbine governor on the steam throttle valves. The plan used in these latest experiments is to deliver the steam from the boiler at the most economical pressure for the load being carried at the moment by the turbine, thus omitting the throttling of steam between the boiler and turbine. The principal advantage in this is that the Benson boiler operating as it does at the critical pressure, requires a much higher percentage of its power generated to operate the boiler feed pump than does a boiler operated at a low pressure.

Increasing the operating steam pressure in an artificial silk mill in Europe from 140 lb. to 500 lb. has been accomplished by adding supplementary evaporating tubes through which boiler water is circulated. The

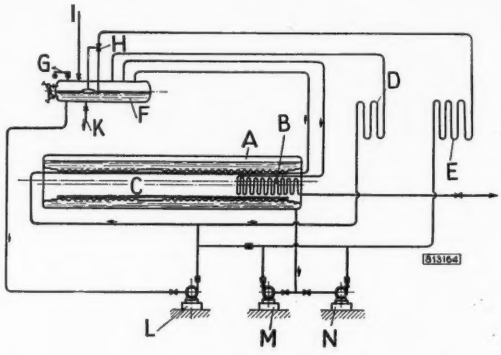


Fig. 5. Diagram of arrangement to increase steam pressure A, existing storage boiler; B, superheater; C, evaporating tubes; D, supplementary evaporating tubes; E, economizer; F, steam water drum; G, safety valve; H, feedwater regulator; I, blowoff pipe; K, drain pipe; L, circulating pump; M, feed pump; N, stand-by pump.

original Cornish boiler is operated at 11 lb. pressure but a feed pump acting as a booster withdraws the boiler water and forces it through an economizer to the high pressure drum from which it is withdrawn and circulated through the high pressure evaporating tubes where it is turned into steam and delivered to the high pressure drum. Entrained water is separated out here and saturated steam at 500 lb. pressure is then passed through the superheater where it is heated to 750 deg. F. for delivery to the engine. An operating efficiency

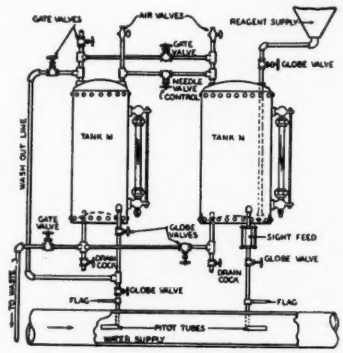


Fig. 6. Continuous, proportional, compound feeder

of about 86 per cent has been obtained by this installation.

Feedwater

Advances in water treatment are becoming more and more involved chemically, as it is recognized that, with boilers of high capacity operating at high pres-

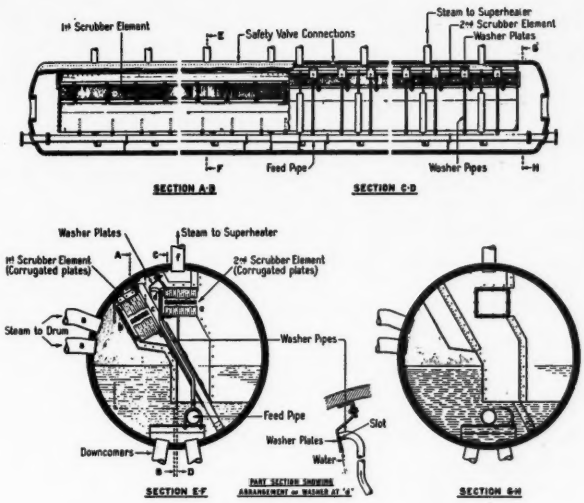


Fig. 7. Steam scrubber in South Amboy boiler as installed in the boiler drum

sures and temperatures, the control of impurities within the boiler must be accurate if boiler failures are to be avoided. So it is that feedwater and boiler water problems are the subjects for considerable research work carried on by chemical engineers. It is recognized that each plant has peculiarities of its own demanding specific treatment, careful control and technical supervision.

For the man in the plant, chemists are devising simple and rapid methods for determining the proper condition of the feedwater and boiler water. One of these recommended for testing the correctness of softened water by H. M. Rivers of Kansas State College, employs a few drops of silver nitrate solution in a small sample of the treated water which indicates by the resultant color whether too little, too much or the correct amount of chemicals have been used in treating the water.

Of recent years the dangers accompanying the presence of free oxygen in boiler water have been recognized and equipment for the deaeration of feedwater was developed. To test the effectiveness of this equipment was a process requiring considerable chemical knowledge and skill. It remained for the Cochrane Corp. investigating the accuracy of the standard Winkler test for the oxygen in water, to devise a test which can be used by the man in charge of the operation of deaerating equipment installed in a plant.

In England important research work in the field of boiler water treatment has been carried on with colloidal conditioning which can be divided into two types. One relies solely on the use of substances which act as protective colloids. The action is entirely physical and use is made of such substances as starch, glue, Irish moss, and the like. The second uses organic substances which form colloidal gels with lime salts. Into this class fall alginates. These not only act as protective colloids but the particles of gel of calcium alginate, in the boiler, absorb a suitable amount of water and thus cannot bake on to the boiler plates and are therefore considered superior to inorganic colloids.

Special committees of the American Society of Mechanical Engineers are at work on boiler feedwater problems and will report their progress at the annual meeting on the subjects of dissolved oxygen, embrittlement of boiler steel and the effect of solution composition on the failure of highly stressed boiler steel.

Some new equipment for use in the treatment of feedwater has been brought into commercial use during the past year, among which is a feeder developed by D. W. Haering, Inc., which is a proportioning unit for feeding predetermined amounts of liquids under varying flow conditions. The feeder uses the differential pressure between pitot tubes as the source of control

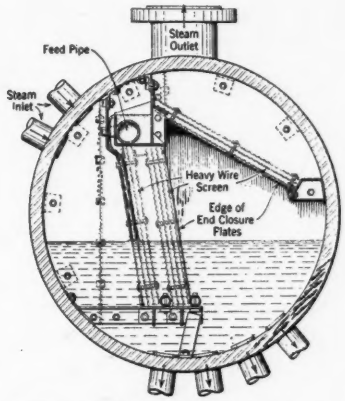


Fig. 8. Diagram of commercial type steam washer

and feeds the reagent into the water supply in proportion to the flow.

Boiler Water

To reduce the carryover of boiler water impurities into the steam piping a scrubbing system was installed at South Amboy station, which is worthy of note since it reduced the carryover from around 8 or 10 p.p.m., which is ordinarily considered good practice, to 0.2 p.p.m. The principle of the design is to remove all possible moisture from the steam and then remove the solid content from the remaining moisture. The first section is a corrugated plate separator removing the moisture, and the second a washer using the incoming practically pure feedwater.

Using similar principles but an entirely different design, Combustion Engineering Co. has developed a steam washer for the market employing heavy wire screen and plates to remove the moisture and solid particles from the steam.

Control of boiler water concentration is aided by a recording meter brought into commercial application by the Esterline-Angus Co., which gives a continuous record of the salt concentration in the boiler water. The principle of operation is the varying resistance of a column of boiler water to an electric current from a constant voltage source. The instrument thus gives to the operator an indication when the boiler should be blown down.

Continuous blow-down systems seem to meet the demands of many operating engineers for a means of maintaining satisfactory boiler water concentration. In one developed by Franklin Power Specialty Co., the water withdrawn from the boiler is flashed into steam which is used to heat the incoming feedwater.

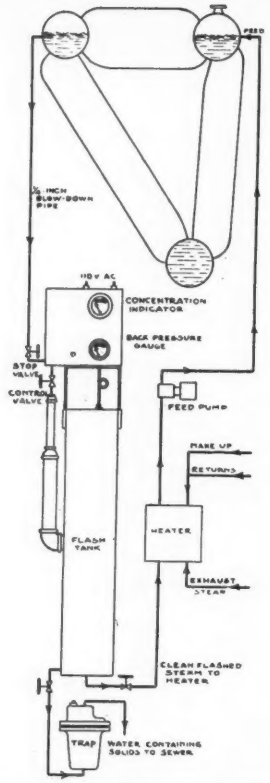


Fig. 9. Continuous blow-down system with flash tank

Another blowoff arrangement which has made its appearance as a product of the National Boiler Improvement Co., has to do with the withdrawal of the scum from the surface and sediment from the bottom of the boiler, the special feature being nozzles properly located throughout the boiler and connected by piping directly to the blowoff piping although the device could readily be used in a continuous blow-down system.

One of the convenient accessories to appear on the market is a two-color gage glass developed by Diamond Power Specialty Co. to show more clearly the position of the water. Red and green bands of light are projected side by side on the gage glass at such an angle that the portion containing water shows green while that containing steam shows red.

One of the dangers in the operation of a pulverized coal furnace is the liability of explosion when lighting off and a distinct contribution to the safe operation of such a plant is a device developed by Bailey Meter Co., which withholds fuel feed until the boiler is thoroughly purged. This is done by the use of two oil sealed bells suspended from a beam to measure air flow through the boiler by the differential draft method. This mechanism operates a contactor which is connected to the air flow mechanism by linkage in such a manner that it is necessary to run the rate of air flow through the boiler up to approximately 60 per cent of capacity before the contactor closes and permits operation of the fuel feeder motor relay or control valve.

In the field of smoke abatement probably the most outstanding feature was the civic works project carried out in Chicago by means of Government funds. This work, directed by Frank A. Chambers, gave employment not only to the 16 inspectors regularly employed by the smoke department but to 168 CWA workers carefully chosen because of their knowledge of combustion and smoke problems. This force of experts was engaged in the preparation of manuals for the correct operation of all types of combustion equipment, the instruction of firemen and janitors in the correct handling of fires not only in classes but by personal demonstrations in offending plants, and in observing stacks, upon which 152,528 reports were made, 4868 violations of the smoke ordinance were observed. The survey showed that marked improvement has been made in dust fall during the past two years, the average per month having dropped from 230.33 tons per sq. mi. in 1932 to 107.7 tons in 1934.

Smoke abatement has been aided by the development of several new smoke indicating and recording instruments which keep the firemen continuously informed as to the smoke condition of their stacks.

Power Plant Fuels

In the search for more economical fuel for power plants, engineers have done considerable experimenting with fuels that are available in their neighborhoods and in many cases have found it advisable to provide equipment that will permit changing quickly from one type of fuel to another in order to meet an emergency condition or to take advantage of changes in market prices. With the completion a few years ago of the gas pipe line from the fields in the Southwest to the industrial centers of the Mississippi Valley, gas began competing with oil and coal as fuel for the generation of steam and is still on the upgrade as compared with other fuels.

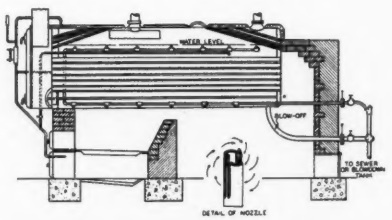


Fig. 10. Blow-down piping with internal nozzles

Also, scientific research is being conducted at various institutions on both anthracite and bituminous coal and better methods are being developed for preparing these fuels for the market as well as burning such prepared fuels as coke and petroleum carbon. Caking action of coal on stokers has been studied by the U. S. Bureau of Mines and the results published. The results obtained with lignite as fuel have been reported from several plants which indicate success with this fuel requires a technique far different from that used with coal, although both stokers and pulverized fuel burners have been successfully employed.

Considerable attention has been given to the selection of the most suitable coal for particular installations both as to cost and burning characteristics. As an aid in this direction, the American Society for Testing Materials has compiled standard and tentative specifications and tests for coal and coke which in-

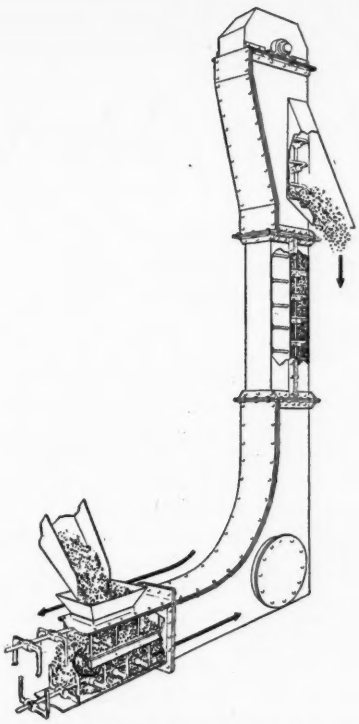


Fig. 11. Continuous flow elevator and conveyor

cludes five specifications, 13 methods of test and the standard definitions of terms relating to coal and coke. Changes, too, have been made in the Commercial Standard on Fuel Oils by the A. S. T. M. which have been found advisable with the changing characteristics of commercial oils available.

Little change has been noted in the fundamental characteristics of coal burning equipment. Several stoker manufacturers have announced improvements in the details of design such as methods of driving, feeding mechanisms and grate bar details. In the small stoker field, a number of new designs have appeared and few boiler installations, no matter how small, are being made that are not mechanically fired.

Several noteworthy developments have taken place in the means for handling coal. One of these developed by Stephens-Adamson Mfg. Co., is the Redler Conveyor, which has the elements of a flight conveyor but the flights resemble bent rods that convey and elevate due to the friction they cause in being drawn through the material conveyed. This is a continuous flow conveyor, its principal advantages being the simplicity with which the discharge of material can be arranged from either vertical or horizontal run.

Engineers in northern plants where large quantities of coal are delivered in cars, will find interest in the coal car thawing equipment developed by the Wellman Engineering Co. This equipment envelops the loaded car in a stream of hot air supplied from oil-burning furnaces and kept in circulation by blowers, about two minutes being required to thaw the coal so it can be dumped.

In the plant of the Iron Fireman Mfg. Co. an interesting installation of screw conveyor has been made to deliver coal from the base of a silo coal storage bin to the fire pot of the stoker. This equipment is automatic, working in conjunction with a stoker that is itself automatically controlled according to the load on the boiler.

So little installation work has been done during the past year in the boiler plants of public utility companies that definite trends in practice are not discernible. In industrial plants, however, there is distinct evidence that a much higher class of engineering knowledge is being used in the design of present day installations than was employed in past years. This year, for instance, new installations employ steam pressures ranging from 1400 lb. down and temperatures from 7760 deg. F. down. These values have been chosen with distinct power and heating services in mind. Each industry, in fact each plant, has peculiarities of its own and the plant design best suited can be worked out only after careful study of all the services rendered and the load schedules to which the plant is to be subjected. The trend of the past year might, therefore, be characterized as toward carefully designed individual plants for specific purposes and definite geographical locations. In the boilers of these plants where the pressures are above 300 lb., water wall furnaces and air preheaters are used almost universally, while in the same range of plants the percentage employing economizers ranges between 30 and 40.

Prime Movers Committee Reorganized

AMONG engineers the reorganization and enlargement of the Prime Movers Committee of the E. E. I. has met enthusiastic approval as the valuable work of the former committee under the N.E.L.A. has been greatly missed as a means of advancing power plant practice. The first meeting of the reorganized committee was held in Chicago on October 22 and 23 under the chairmanship of Alfred Iddles.

Oversight of all technical questions relating to power production except hydraulic power is included in the scope of this committee. Consideration will therefore be given to a great variety of equipment in the steam raising plant, the application of power to electric generators, and the auxiliaries and appurtenances thereto, as well as fuels, lubricants and water supply.

The exchange of experience in the field of power generation as carried on by this committee has a value that is probably greater than in any other technical department of the industry.

At the recent meeting, round table discussions were made an important feature. Considerable time was devoted to a resume of the present situation of the industry with respect to capacity and the rate at which existing capacity may be taken up with increased loading as this may occur due to increased industrial activity.

In particular the problems relating to the superimposition of high pressure units on old stations were discussed in this connection.

Other topics discussed included the treatment of feedwater and cooling water, the rehabilitation of condensers, metallurgical developments and the disposal of fly-ash.

Advances *in* Prime Movers *a*

Refinement of Detail Largely Through Metallurgical Advances; Widespread Use of Vapor Refrigeration and Rapid Development of Light Weight Diesels Characterize Year's Progress

LIKE so many other lines, steam turbine development during the past year was not startling. There were some changes but these as a rule reflected improvements in detail through research in allied lines. Probably the announcement of a new 110,000 kw. General Electric steeple compound unit for the River Rouge plant created the most widespread interest for two reasons: It is the first 1200 lb., 900 deg. F. unit to be announced; and it will operate condensing from 1200 lb. without reheat.

Furthermore it is one of the two largest industrial turbine units and will be considerably more efficient than the similar 1200 lb., 750 deg. F. unit installed in the same plant in 1930. Like the first unit, the machine consists of two 55,000 kw. units, the high pressure cylinder being mounted on top of the low pressure one. The general dimensions will be; length, 57 ft. 6 in.; maximum width, 23 ft.; overall height from floor, 21 ft., giving a volume occupied of less than a quarter of a cubic foot per kilowatt of capacity.

165,000-Kw. Unit

In the central station field, the large 165,000 kw. Westinghouse unit for Richmond Station now nearing completion, is of unusual interest. Not only is it one of the largest single shaft units yet built, a tandem compound with a double winding generator, but it is the first unit to be built with the governor and lubricating system separated so as to eliminate the fire hazard present with high temperature steam and large quantities of oil around the steam chest.

Equally important is the 80,000 kw., 1200 lb., 850 deg. F. Allis-Chalmers turbine for Port Washington. Like the station itself, the turbine is one of the first high temperature units to be designed and incorporates many interesting details. At full load the steam flow will range around 690,000 lb. per hr. and this will be supplied by a single boiler unit with a combination superheater and a radiant reheater. It is said that using one rather than two boilers in the station reduced the cost $4 per kw.

Hollow Blades

During the past few years metallurgical research has been directed toward meeting the demands for higher temperatures and for combating corrosion and erosion especially in the low pressure ends. Suitable alloys have been discovered and suitable erosion shields developed so that this problem is well on the way to solution. There is, however, a constant demand for higher speeds and larger sizes and to help meet this demand Parsons has developed, and is trying out, hollow blades which give a material weight reduction and allow a 15 per cent increase in speed due to the lower center of gravity. It is expected that the upper limits of a 3000 r.p.m. machine can be raised from 15,000 to 20,000 kw. for single exhaust and up to 40,000 for double exhaust. As an example of the difference it is reported that a 17-in. hollow blade with an erosion shield weighs only 1½ lb. as compared with a usual weight of 2 lb.

Condenser developments have been few and of a detailed nature. The most promising research work being a recent report from Germany that a film of soap or stearic acid on the steam side of copper and brass tubes facilitates drop formation and may possibly point the way to higher heat transfer coefficients and smaller condensers.

Tube Packing

One detail that has created widespread interest is a new Crane condenser tube packing designed to eliminate rolling of tubes and yet allow one end to expand freely. This consists of a special streamline ferrule and two metal cones, one hard and the other soft, which firmly grip the tube on one end. The other end is packed with metallic packing without a ferrule so as to take care of expansion. Another development of the same company is a special packing or distance piece which allows necked or damaged tubes to be reused, with the outlet end packed with metallic packing as before, even though both ends of the tube are necked.

Strainers have long been a standard accessory where cooling water is used and two very interesting self-cleaning strainers built in medium and large sizes have been developed. The Elliott self-cleaning strainer built in sizes up to 24 in., has three cylindrical screens so arranged that the water flows from the inside out. A scraper, driven continuously by an integral water motor, flushes the screen by backflow, through a V-shaped traveling trough, to the drain. The other strainer is the Phillips which is self-cleaning but manually operated. It consists of a Y-shaped valve with two bucket strainers arranged with cutoff valves and by-passes so that either bucket may be cleaned when desired. A 12 in. valve at State Line is said to handle a flow of 4260 g.p.m. with a pressure loss of 120 in. of water.

Among small turbines there has been a decided extension of stainless steel and welding for the purpose of adapting the smaller units to the higher pressures

s *and* Service Equipment

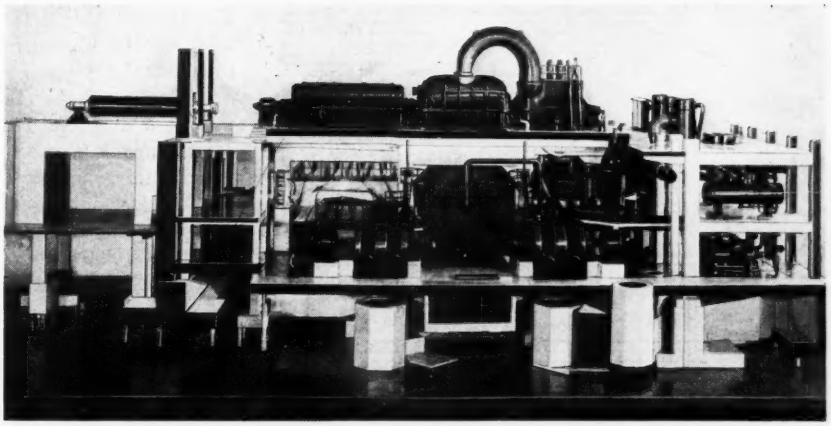


Fig. 1. Model of the new 165,000 kw. turbo-generator unit at Richmond station. (Photo, courtesy United Engineers Constructors, Inc.)

and temperatures and making them more adaptable to drives where the geared motor unit is also applicable. The new Coppus built-in turbine and speed reducer unit is an excellent example of a development along this line. These built-in speed reducer units can be supplied with either single or double reduction gears, clockwise or counterclockwise rotation and are extremely compact in design. De Laval has combined a similar unit of its own design with a vertical IMO rotary pump to make an extremely compact unit of 500 g.p.m. capacity for handling lubricating oil, or, fuel oil directly to the burner system. Terry also developed a compact geared turbine pump unit consisting of a relatively high speed turbine driving a pump through a worm gear and intended primarily for lubricating oil or fuel oil service and built for either wall or floor mounting.

Steam turbine developments, which for years have been front page news among the prime movers, has this year been thrust back among the department store advertisements by the Diesel. In fact the Depression, with a little judicious pushing by various interested parties, took the Diesel by the hand and landed it on the front page of practically every newspaper in the land to make the "man-in-the-street" Diesel conscious.

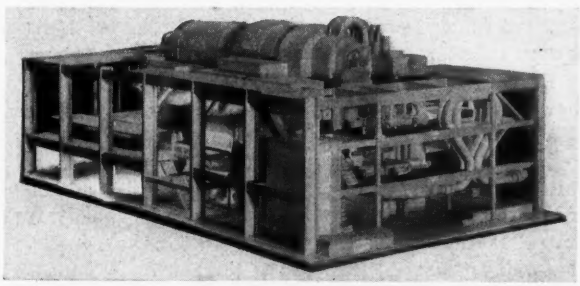


Fig. 2. Model of the Port Washington 1400 lb. turbine. (Photo, courtesy The Milwaukee Elec. Railway & Light Co.)

After 2 yr. education at the World's Fair and a few preliminary trips of the Burlington, light-weight, Diesel train, Zephyr, the country was considered ready for the super-feat of railroading—a coast to coast record breaking dash of the Union Pacific light weight train powered by Winton Diesels. The 30 yr. record of Death Valley Scotty over portions of the route was broken and although the Scotty's spontaneous showmanship was lacking, the trip was considered as news. At times the speed was phenomenal, and the run was made in a little over 56 hr. The fact that such a trip has not been made before proves the general inaptitude of the steam locomotive for high speed, light train, passenger service.

Flying Hamburger

This has of course been recognized for some time by engineers in this country and abroad although apparently it took the Depression to drive the fact home in this country. The appetizing "Flying Hamburger" is not a gastronomic delight but an articulated streamlined train powered by two 410 hp. Diesels which maintain a 2 hr. 18 min. schedule over the 180 mi. between Berlin and Hamburg.

The most extensive development along this line was on the Dutch railways where 15 Diesel trains were put in service last May on the Amsterdam-Rotterdam and Hague-Arnhem lines. This number was scheduled to be increased to 40 in October. There are also articulated streamlined trains and although each powered by two 210 kw. units, have a speed of 93 m.p.h. Denmark has made wide use of the Diesel train for a period of 10 yr. and the Royal State Railways of Siam purchased a number in 1930. It is said that on the Danish narrow-gage, freight locomotives of 4000 hp. are possible and that this could be increased on the wider gage American railways.

Since about 1925 the Diesel has been active in Amer-

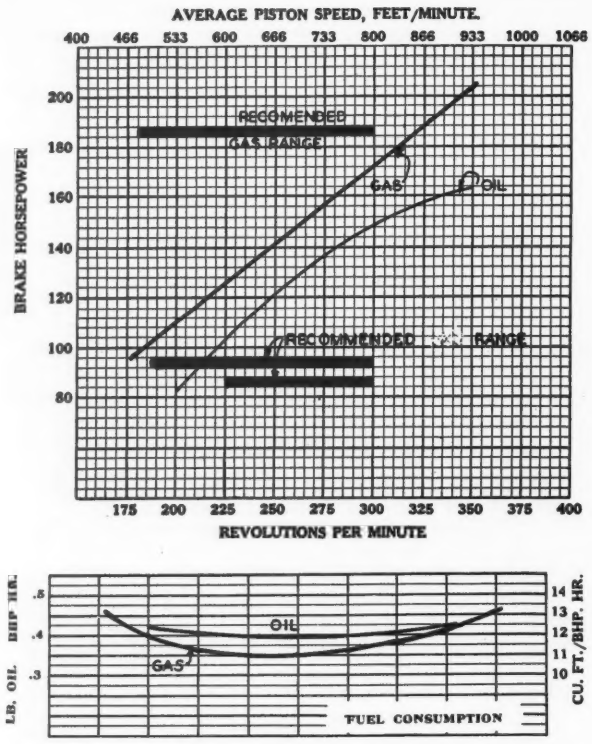


Fig. 3. Performance of a 12½ by 16 in. convertible Reid engine with gas and oil fuel

ican railway work and some 150 locomotives are already in service, Cummings, Ingersoll-Rand, McIntosh & Seymour, Westinghouse and Winton being some of the engine companies most interested in the development. The electric locomotive, the Diesel-electric locomotive as well as their offspring the high speed, light weight electric and Diesel-electric passenger train, are undoubtedly destined to play an important part in American railroad practice. A diagram of the electrical connections and control of a Westinghouse Diesel-electric locomotive is shown by Fig. 4. This company now builds four locomotive Diesels of the 4-cycle type, giving a range of size from 250 to 800 br.hp. These engines range around 30 lb. per br.hp. and the large engine used double may be used in 1600 hp. locomotive.

Of course the railway field is but one phase of the light-weight Diesel development which is making itself felt in the automotive field so strongly that the Diesel truck especially may soon have complete domination of the field. In aviation and in passenger automobiles the result is farther off but the large number of companies interested in experimental work shows that all branches of engineering are fully Diesel conscious.

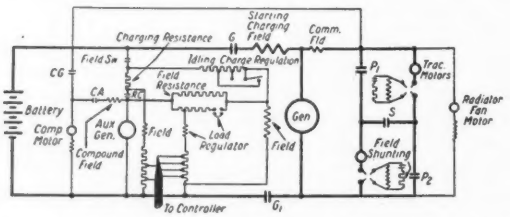


Fig. 4. Electrical connections and control diagram of a Westinghouse Diesel-electric locomotive

Development of small Diesels has brought out the suggestion that the future solution of the industrial power problem lies in the utilization of small engine units, perhaps semi-mobile, at points where the power is actually used. As an example of the development along the small Diesel line there may be cited the small Fairbanks, Morse generating sets available in either a.c. or d.c. in units of from 6 to 40 kw. The cylinder size is 4¼ by 6 in. and the operating speed 1200 r.p.m. The Harnischfeger Corp. recently brought out a somewhat similar Diesel unit in capacities ranging from 35 to 50 kw.

Alloys and metals primarily for weight reduction purposes and increased strength are becoming more common each year and to meet the demands for a light weight unit, the new Hill V-8 is available in two types; cast iron weighing 2500 lb. and aluminum weighing 2000 lb. This engine has a 5 in. bore, 7 in. stroke and is rated at 200 br.hp. at 1700 r.p.m. The cylinders are cast en bloc at an angle of 30 deg. from the vertical.

Opposed Pistons

Several new opposed piston designs have been announced recently. One of these, the Stearns Diamond is an 8 cyl. engine with 16 pistons. The design uses two opposed-type pistons with the cylinder bent at a slight angle near the meeting point of the two pistons. The cylinders arranged in pairs give the characteristic diamond shape. The engine develops about 160 hp. Fairbanks, Morse has also developed a light-weight, opposed piston engine weighing about 20 lb. per hp. The engine is built in five cylinder sizes ranging from 5 by 6 in. to 12 by 15 in. in sizes from 250 to 2400 hp.

Perhaps the most unique Diesel development, however, is the Sterling Crankless Engine made in sizes up to 625 hp. Fundamentally the engines consist of four or six horizontal cylinders, each with two opposed pistons, arranged concentrically around a crank assembly consisting of the crank, two wobble plates, or, inclined discs, and a scavenging air distributing valve. Fuel is injected into the compression space between the pistons and the pistons, moving away from each other, bear on the inclined discs and cause the shaft to rotate.

One of the most interesting features of the engine is the piston type scavenging blower. The air pistons, driven directly from the back of the power pistons, compress the air to from 4 to 6 lb. ga. A single air distributing valve on the crank serves all cylinders and is the only valve used. Overall dimensions are comparable in size to a gasoline engine of the same power but the head room is considerably less. Weight per horsepower ranges from 13 to 20 lb.

Of course not all the work done during the past year was on small engines. Busch-Sulzer for instance announced a new design of two cycle, single acting engine with cylinder dimensions of 19.5 by 27 in. and built up to 12 cyl. units developing as high as 10,000 br.hp. Such large engines are, of course, primarily for central station service, a field in which the Diesel is now well established throughout the world.

The largest Diesel central station in this country, the Vernon, Cal. municipal plant, has been in service

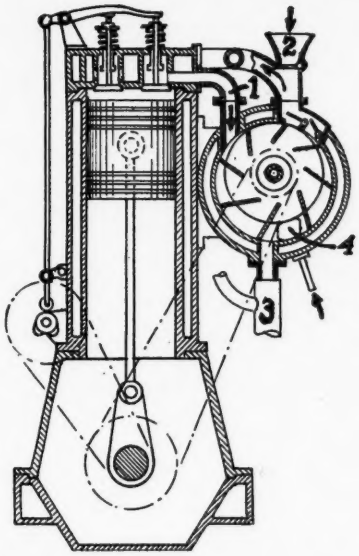


Fig. 5. Exhaust gas driven supercharger patented by Buchi in England

about a year with such good operating results that a vigorous denial that Boulder Canyon power was being considered was recently issued. This station consists of five H.O.R. 7000-hp. engines driving 5000-kw. Allis-Chalmers generators. The engines have eight 24 by 36 in. double acting, two cycle, solid injection cylinders and shop tests showed a full load fuel consumption of less than 0.38 lb. per br.hp. hr. Each engine has a Foster Wheeler waste heat muffler boiler and an Allis-Chalmers motor driven scavenging air blower. The thermal efficiency of 37 per cent and the mechanical efficiency of 90 per cent testify to the excellent performance. It is said that from detailed estimates based on prevailing prices of fuel oil and a capacity factor of 50 to 60 per cent, engines of such fuel economy should produce power for less than 5 mills per net kilowatt hour, including all operating and fixed charges.

This agrees with reports of the Copenhagen (Denmark) station where the world's largest Diesel, a 22,500 hp. Burmeister & Warn engine is installed. The station cost is said to be about 190,000 pounds sterling for the one unit or about 700,000 pounds sterling for four units, giving a unit cost of about $56 per kw. of capacity. With three cent per gallon oil, the estimated overall cost is about one-half cent per kw-hr.

The world's largest Diesel station, the municipal station at Shanghai, China, recently ordered a 13,700 hp. Sulzer engine which will increase the plant capacity to 51,200 kw. Greenville, Tex. recently added two units, one 1000 hp. and one 1450 hp. Nordberg engine to this plant and the Imperial Irrigation District not long ago announced the purchase of 3,000 kw. of Hooven-Owens-Rentschler engines for use as standby equipment for hydro plants on the All-American Canal upon which construction was recently started.

In Germany experimental work on the coal dust engine continues, particularly through the German Dye Trust on a 450 hp. unit. Thermal and mechanical efficiencies are good and it is thought that the problem of undue cylinder wear caused by ash has been solved although it seems that the economical removal of the ash itself is still a problem. It is not thought that the future development of this type engine will greatly influence steam practice but will offer severe competition to the oil burning engine.

In addition to the development of complete new engine designs there has been much work done on improvement of details. For instance, supercharging offers certain advantages of increased power output especially for the higher elevations. Figure 5 shows an exhaust gas driven rotary blower recently patented by Buchi in England. Buchi, it will be recalled, is one of the leading advocates of supercharging by utilizing the waste gases in a turbine to compress the supercharging air. If this is not done the power required for compressing the air practically wipes out any gain from the supercharging thus increasing the heat stresses in the engine to no useful purpose.

The patent mentioned covers a rotary blower of the sliding valve type. Exhaust gases from the engine cylinder enter the blower at 1 and turn the rotor counterclockwise, finally leaving through the exhaust manifold 3. Fresh air is supplied through the port 4, is compressed on the right side of the rotor, and discharged through check valves to the cylinder. At light loads air may be drawn in through the auxiliary valve and inlet 2. If necessary, some additional power may be supplied from the shaft as indicated by the dashed and dotted drive.

Due to the prevalence of natural gas, the gas engine, and the convertible gas-Diesel engine continue to play an important role especially in the Middle West. Engines are designed so that they may be converted in a few hours' time by changing cylinder heads, fuel pumps, etc. The performance of a convertible Reid, Type DC, 12½ by 16 in. twin, two cycle engine is shown by Fig. 3. The oil was a 36-40 Be'. fuel oil running 18,000 B.t.u. per lb. and the gas a 1200 B.t.u. per cu. ft. natural gas.

Oil Research

The increasing importance of the Diesel is well illustrated by the importance attached by industry to the A.S.T.M. classification and standardization of Diesel fuel. This classification divides the fuel into five grades with suggested minimum limiting characteristics necessary to insure economical, satisfactory engine performance. Oils are classified with respect to flash point, water and sediment, viscosity, carbon residue, ash, pour point and ignition characteristics in accordance with the requirements of engines classified according to speed, type of injection, cylinder size and preheating equipment.

Research on spray and fuel injection and on knock is being carried out in a number of laboratories under the co-operation and supervision of a special research committee set up by the A.S.M.E. and other interested bodies. In spite of the large amount of research on these subjects there is still much to learn. It is well known that the ignition quality of a Diesel fuel is dependent generally upon its chemical composition, but as yet no standardized method of measuring it has been developed which will give results which are valid in terms of actual engine practice and can be generally accepted as a reproducible routine method.

In order that the work on the ignition quality of

Diesel fuels might be carried out in a coöperative manner, a number of interested laboratories have recently formed a Volunteer Committee to investigate this problem. It was not the Committee's intention to encroach upon any work that is now being carried out by recognized committees of the various societies, such as the A.S.M.E. and the A.S.T.M. It was felt, however, that the delays caused by difficulties that would be encountered in obtaining necessary funds to carry out any large program of Diesel fuel research could, to some extent, be minimized by a small group of men carrying out a coöperative program of work in their own laboratories, which would hasten preliminary work on important phases of coöperative Diesel fuel research.

While the research work may do much to improve performance, the Diesel is already well established in all lines of endeavor. The Biennial Census of Manufacturers taken in 1934, lists 836 Diesels and 308 semi-Diesels as built in 1933. The majority of these are in the 50 to 400 hp. range.

Many of these units drive generators but that is not the only direct drive application. The direct drive compressor is becoming increasingly popular. Such a design for air compressors was recently announced by Ingersoll-Rand. These units consist of vertical 4 cycle, V-type gas engines direct connected to standard horizontal compressor cylinders. Units are built in four sizes from 60 to 260 hp. with from two to eight power cylinders.

A somewhat different arrangement is used in the new Worthington combination unit known as the Unibloc. In these units, intended primarily for refrigeration service, a compressor cylinder is mounted directly on the base of a standard Worthington, vertical, four-cycle, Diesel or gas engine. The piston of one power cylinder is replaced by a cross head, connected by a piston rod to the compressor cylinder situated directly above. In the larger sizes the number of compressor cylinders is increased to get the desired capacity.

Freon

Increasing use of freon also stimulated new designs as for instance the enclosed design of the Frick Co. This new line intended primarily for air conditioning work, but equally applicable to ammonia booster service, is built in sizes ranging from 15 to 300 t., all totally enclosed, single-acting, twin-vertical, cylinders with plate valves. Worthington also announced a new design of twin, single acting compressors, for either ammonia or freon and ranging from 1 to 100 t. capacity. York added four new sizes to its double cylinder air cooled units to give a complete line of 14 sizes ranging from ¼ to 7½ hp.

Air conditioning has opened up a field of steadily increasing importance. One of the important installations of the past year being the 600 t. Carrier installation in the new Field Bldg. in Chicago. The Chicago Tribune installation of a 600 t. Westinghouse vacuum refrigeration system showed how this type of equipment could be advantageously used in an existing office building. Probably the most spectacular installation, however, was at Rockefeller Center in New York. The total refrigeration in this group of seven buildings

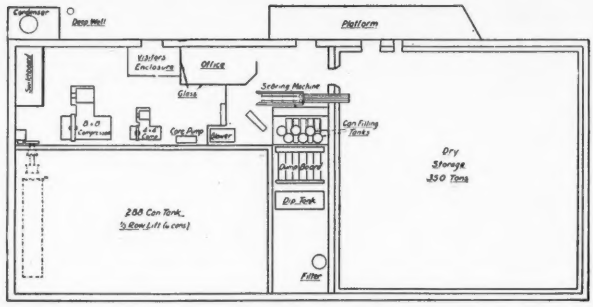


Fig. 6. Layout of the Frick one man one shift automatic ice plant

totals some 4450 t. The bulk of this is Carrier, although there are two 300 t. steam jet refrigeration systems, one Ross and one Westinghouse. Air conditioning will also use the largest electrical refrigerating machines ever built, 2000 t. Carrier units for the South African gold fields where three units will be used to air condition the world's deepest gold mine, the Robinson Deep, which has penetrated 8380 ft. below earth's surface near Johannesburg. The units are 10 ft. high, 18 ft. long and 16 ft. wide, each driven by a 750 hp. electric motor, and will produce 2500 g.p.m. water.

The Vacuum system also has a large potential field in industrial refrigeration, the 600 t. Foster Wheeler steam jet installation at the Anheuser Busch Brewery being an excellent example. There, 720 g.p.m. of 85 deg. F. water is cooled to 65 deg. F. Recently a line of small sized water coolers designed for steam pressures as low as 3 lb. gage were announced by the Elliott Co. Although steam jet operation is customarily used with vacuum refrigeration any other type of compressor capable of handling large volumes of low pressure water vapor may be used. Ingersoll-Rand has developed a centrifugal compressor for this particular service, thus making the vacuum refrigeration system as a whole, independent of the steam supply.

Steam jet units are particularly adaptable to chemical or industrial problems where cold water is required for maintaining temperature and humidity conditions such as with rayon, cotton goods and confectionery; where cold water is required for condensation of low boiling point vapors, such as the petroleum and spirits industries, and a wide range of chemical products; used as the second stage and for interstage cooling of CO_2 refrigeration for the manufacture of dry ice, quick frozen foods and ship refrigeration; in the manufacture of films, paper, etc.

Industrial Application

A specific installation, which is to be made by Westinghouse this winter, will illustrate one of these problems: a whiskey distillery uses the open system of cooking and cooling of mash. The cooking and cooling are carried out in a large vat which has three groups of copper cooling coils fitted along the side walls. After the cooking is completed it is necessary to rapidly cool the mash. Formerly this has been accomplished by circulating well water through the coils in parallel. During the major portion of the year the well water is available in sufficient quantity and at a low enough temperature to do the cooling in about

two and one-half hours. During the summer it has been found necessary, however, to shut down the distillery for a period of 2 to 3 mo. An analysis showed that by the addition of a moderate size, steam jet, vacuum cooling unit that the cooling period could be shortened and that the distillery could operate without reduction in capacity through the summer months and that the profit from the additional product would pay for the additional equipment and operating charges in a very short time. Part of this advantage is due to the inherently large capacity of the steam jet unit during the early phase of the cooling cycle. Similar problems are present in many industrial processes.

Another specific problem also brought out by Westinghouse illustrates a different application and shows the versatility of the equipment. On several existing fruit carrying steamers, which travel through South American and Canal-Pacific routes, the present CO_2 refrigeration units lose a considerable portion of their potential capacity when travelling through tropical waters due to the high temperature of sea water through the CO_2 condensers. An analysis shows that making these a two-stage refrigeration unit by adding a steam jet unit to furnish the condenser water for the CO_2 condensers will restore the full normal capacity of the compressors and at the same time reduce their power consumption, with a lower investment, weight and space than if additional CO_2 compressors were installed. A similar installation has been made by Westinghouse in one of the newer dry ice making plants to cut the number of compressor stages and power consumption.

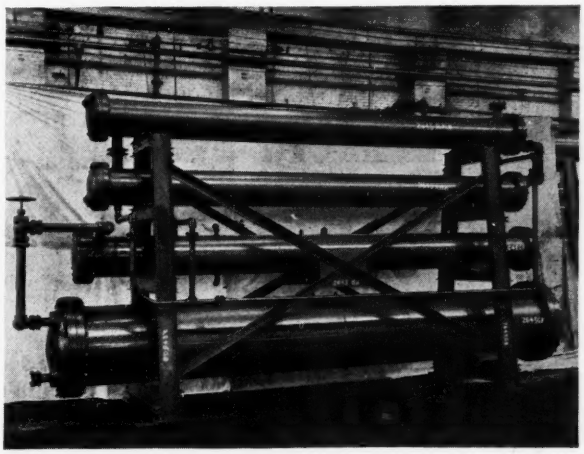


Fig. 7. Vogt welded steel ammonia generator and rectifier

In the ice making field detailed changes have been made in equipment, one of the interesting developments being a new type of condenser, the Guild design, fabricated of Byers wrought iron, which departs from traditional practice. A hot gas header at the bottom is fitted with a row of dead end tubes pointed upward and cooled by a gravity flow of water over the outside. In this as in other lines of equipment welding is playing an increasingly important part. Fig. 7 shows a Vogt, welded steel, ammonia generator and rectifier, one of the many applications of welding made by this company during the past year.

As a substitute for brine in cooling tanks, oil has been tried with some success as a solution of the corrosion problem. The oil used has a specific heat of 0.445 at zero deg. F. as compared with about 0.70 for calcium chloride. The viscosity at 100 deg. F. is about 65 sec. and the specific gravity 0.85 to 0.87. Due to the higher viscosity, the temperature difference on long cabinets is said to be somewhat higher than normal.

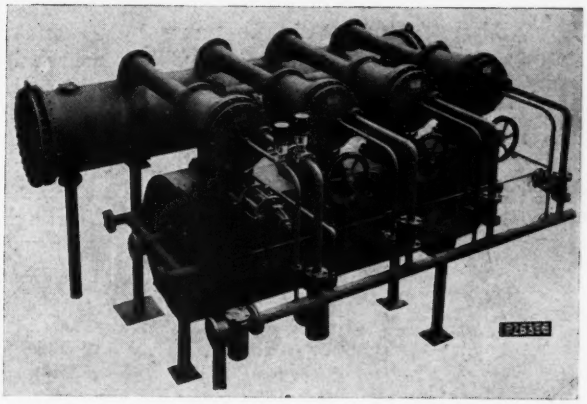


Fig. 8. Westinghouse vacuum refrigeration unit consisting of an evaporator (in the foreground), 4 booster ejectors and a surface condenser. Air binding of the condenser is prevented by a 2 stg. ejector with an inter and after cooler mounted between the evaporator and condenser

So far no ice plant installations have been made, due to the high viscosity at low temperatures, difficulty of water overflow freezing in the bottom of the tanks and the spreading of oil over the floor by the ice cans. This problem is being tackled in the laboratory, however, and a suitable oil may yet be developed for this service.

In the ice making field the Frick one man ice plant installed for the Carlisle Hygienic Ice Co. is a notable achievement. The layout of the plant is shown by Fig. 6. The final solution of the one man plant has been accomplished chiefly through two things: arrangement of the plant so that the operator can view all parts from his glass enclosed office, and the installation of both group harvesting equipment and full automatic control for the machinery. In this instance the plant is also a one shift plant, that is one man works during the day time and then goes home leaving the doors locked and the equipment to operate itself until the next day.

Probably the most spectacular refrigeration development of the year is the nautical experiment of George Claude, inventor of the neon lamp and sign. This consists of the rebuilt 10,000 t. SS. Tunsie fitted out to make ice off the coast of Brazil. Power will be developed in low pressure turbines operating on the few degrees between the surface water temperature and the temperature at a depth of 2000 to 3000 ft. Warm water from the surface will be used in the boiler and the cold water from the lower levels will be used in the condenser. Of the 1800 kw. about 1200 kw. will be utilized in the manufacture of ice. The ice made will be sold in the larger cities, probably Rio de Janeiro initially, for all cooling services except for drinking purposes. Quite optimistically Claude looks forward to making ice so cheaply and in such quantities as to materially influence living conditions in the Torrid Zone.

Hydroelectric DEVELOPMENTS R

INTEREST IN THE hydroelectric field at the present time, particularly in this country, is centered mainly in the great projects being carried out under the various public works programs of the Administration. These projects, especially those on the Colorado and Columbia Rivers, are of such magnitude as to be spectacular. The technical and engineering problems involved require the accumulated skill and knowledge of a half century of scientific and engineering practice for their solution. All of those which have been started are still under construction and will be for some time to come, though for the most part they are considerably ahead of schedule. Outside of these government projects there has been little new construction in this country in the hydroelectric field though extensions to existing plants are being made in a number of cases. In Canada, except for the completion of the Rapide Blanc station of the St. Maurice River this year, there has been comparatively little activity. The Bridge River project in Canada which was scheduled for an ultimate capacity of 300,000 hp. has been postponed for the time being at least. In Europe a number of large projects are in course of development.

It is rather difficult to present a comprehensive picture of the trend in hydroelectric practice because, at the present time at least, hydroelectric developments are being carried out along lines which differ from those of former years. Despite the great government projects now under way the future growth of the hydroelectric industry does not appear to be very clear. This is due mainly to the fact that most of the "obvious" and economically feasible projects have been developed or are being developed and that the remaining potential projects depend upon future conditions and circumstances which are not easy to foresee.

At the present time approximately 40 per cent of the electric energy generated for public consumption in the United States is produced by water power. This figure includes that produced by electric light and power plants, electric railways and certain manufacturing and public works establishments.

This percentage has varied slightly during the last seven years but this variation in percentage has been due more to the variation in the amount generated by thermal plants than to an actual variation in the amount produced by water power. As shown by the accompanying chart, Fig. 2, the amount of electricity produced by water power has remained remarkably constant at around 34 billion kilowatt-hours. The reason for this no doubt lies in the fact that the total amount of energy generated in these years has decreased and, neglecting fixed charges, since the operating cost of hydro plants is less than that of thermal plants, the hydro plants have been operated at normal capacity while the load on thermal plants was decreased. Regardless of the nature of future hydraulic development, it is quite obvious that in the public electricity supply, hydroelectric energy is and will continue to be an important factor, particularly in view of the extensive developments being carried on by the government.

Until the present time, with a few possible exceptions such as the Muscle Shoals plant and developments involving irrigation features, hydroelectric projects have been developed almost entirely in accordance with economic considerations. These economic aspects are quite involved and not generally appreciated by the public. In the eastern part of the United States, for example, certain hydroelectric sites which were not economically feasible years ago now, because of the great increase in thermal plant capacity, have become economically desirable and have been developed. The recent developments on the Susquehanna River at Conowingo and Safe Harbor are typical examples of plants

Fig. 1. Recent View of Boulder Dam Development (Photo, Bureau of Reclamation)

that could not be justified without a previously developed large thermal capacity. In other instances the development of hydroelectric power sites has been directly related to the development of certain industries requiring large quantities of cheap electric energy. The recent developments in eastern Canada are typical in this respect, the plants built there having for their primary purpose the supply of large blocks of power to electrometallurgical and paper industries. The economical justification of these developments is based upon the fact that the power demand of these industries may be regulated so that for the largest part of the time the demand will be synchronized with the available supply of energy.

The Social Aspects of Power Development

It is because of this dependence of hydroelectric developments upon economic considerations that the many government projects now in process of development are of interest, because in their development for the first time the social aspects of a potential power supply are to be given consideration. In the TVA development there will be effected a complete coördination of not only the industrial and agricultural resources but also the power resources of a large area for the benefit of society as a whole.

These aspects of the hydroelectric power situation are of importance because it is only through a recognition of the social aspects of power developments that many possible power sites can expect to find fulfillment. It is interesting, too, to consider that the technical status of electric power development fits in well with this social movement in the utilization of our hydroelectric resources. In the past it was the common practice to operate plants independently but with the present development of interconnection and transmission the modern trend is to make hydroelectric plants links in power systems. As pointed out in a recent survey of hydroelectric developments by the American Institute of Electrical Engineers, the advantages of such interconnection are such that no development of any importance can overlook them. One of the principal advantages of interconnection, of course, is the more effective utilization of the power generated by all the plants on the system, not only the hydro plants but the thermal plants also. When the first interconnections between hydro plants were developed, the hydro plants in many instances served as base load plants while steam plants often were provided to carry peaks or for emergency operation. This situation has altered somewhat in recent years and now in many cases the hydroelectric plant is the standby for thermal stations. Because a hydroelectric unit may be started from standstill and connected to the system within a very few minutes, the hydroelectric plant is better adapted for standby service than a steam plant.

While there are a number of small hydroelectric projects under construction throughout the world, there are at the present time about a dozen major projects involving 200,000 hp. or more each in process of development, most of them being in the United States. These, together with their initial and ultimate capacities, are as follows:

Development	Country	River	Capacity in horsepower Ultimate	Being Installed
Grand Coulee	U. S.	Columbia	2,660,000	147,000
Boulder Canyon	U. S.	Colorado	1,835,000	515,000
Bonneville	U. S.	Columbia	688,000	114,000
Dura	Norway	Sunndalfjord	550,000	550,000
Ft. Peck	U. S.	Missouri	532,000	
Wheeler	U. S.	Tennessee	375,000	48,000
Diablo	U. S.	Skagit	320,000	166,000
Esla	Spain	Esla	300,000	225,000
Dixence	Switzerland	Dixence	225,000	225,000
Kembs	France	Rhine	220,000	183,000
Mareges	France	Dordogne	210,000	210,000

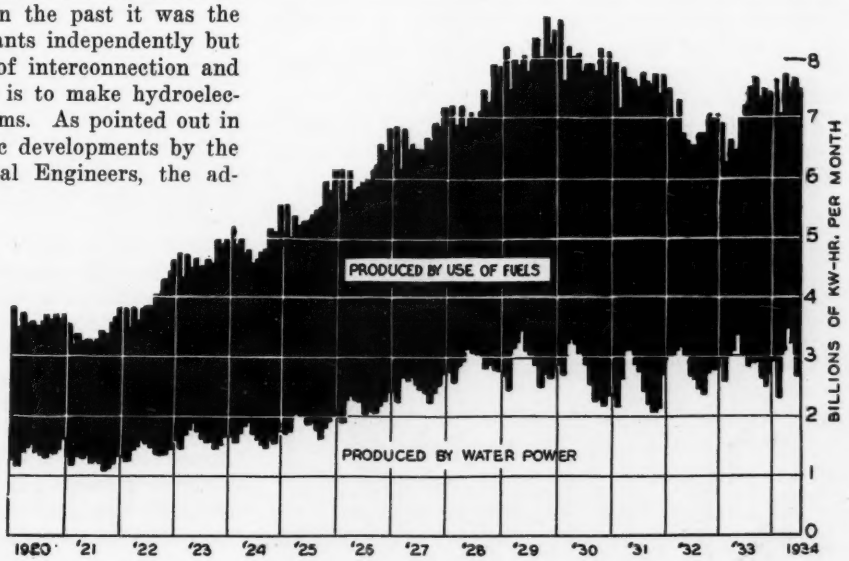


Fig. 2. Chart showing relative amounts of power generated by water power and fuels in the United States over a period of 14 years

Fig. 3. At work on the great Columbia Basin Project. Railway and highway excavation across slide area. Sept. 28, 1934. (Photo, Bureau of Reclamation)

The construction of so many large projects, naturally, has involved the solution of many unusual and difficult problems all of which has contributed greatly to development in all branches of the field, and it has stimulated research into the fundamentals which underline the design of hydraulic equipment.

In point of efficiency of generation, there is little more to be accomplished. There are units in service today with full load efficiencies of close to 94 per cent so it is evident that there is little opportunity for further improvement in that direction. The main efforts today are being directed towards the improvement of efficiency for conditions of head and loading different from that of maximum efficiency.

Methods of measurement of water flow have continued to receive attention and while there still is no method of measuring water flow that will give a degree of accuracy approaching that obtained in, say, the measurement of flow of electricity, the methods in use today are quite adequate for their purpose. A novel method for measuring flow in convergent intake sections was developed in Switzerland by Escher Wyss and its application in the acceptance tests at Wettingen gave a high degree of accuracy.

The question of water hammer is receiving much study and the work on cavitation started several years ago has been continued. Much valuable data regarding the theory and mechanism of cavitation has been disclosed in the last few years. The excellent work of Dr. Spannhake at Massachusetts Institute of Technology in cavitation research has borne fruit and additional commercial laboratories for research work on cavitation are being undertaken.

The excellent report on Water Hammer issued in connection with the Symposium on Water Hammer by the Hydraulic Division of the A.S.M.E. last year was followed by a supplement this year. This supplement contained not only the discussions presented at the symposium in 1933 but also a number of written discussions submitted by engineers from various parts of the world.

Boulder Dam More Than Two Years Ahead of Schedule

Referring specifically to the work now under way, the most interesting no doubt is that involved in the construction of Boulder Dam development. This project is considerably better than two years ahead of schedule and if present progress continues the tentative program called for in placing the contract will be completed in May of 1935. In April of this year the dam had reached approximately half its height, but since then work had gone forward rapidly and in October the dam had reached the height shown in the accompanying photograph. The four intake towers have been practically completed. The removal of the upstream cofferdam was started during the fall and the storage of water in the reservoir has begun. Construc-

Fig. 4. First cofferdam at Wheeler dam, showing power house site. (Photo T.V.A.)

tion of the actual power plant also is well under way and it is expected that the first generating unit will go into operation in 1935. The initial installation comprises four 115,000 hp. units and one 55,000 hp. unit. Ultimately there will be fifteen 115,000 hp. and two 55,000 hp. turbines. The regulated flow will generate continuously 700,000 hp. with the turbines loaded at the best point of efficiency and at an operating head of 530 ft. The turbines are of the vertical shaft, single runner, Francis type with spiral casings.

The cableway used in the construction of the power house and penstocks at Boulder Dam is of especial interest because it is the largest ever constructed. To gain the floor level on either side of the river by means of a connecting railroad would require traversing an unusually rugged and inaccessible country. Some 3.8 mi. of very difficult railway would be required in addition to a bridge over the Colorado River. A much more economical and more usable arrangement than such a railroad is the great cableway which has been constructed. This cableway, which has a capacity of 150 tons consists of six main track cables 3.5 in. in diameter stretched 1226 ft. across the canyon. The maximum lift is about 600 ft. The anchorages consist of tunnels driven into the canyon walls 60 ft. in which anchor bars were concreted in place. In order to prevent the load from turning two separate hoists are used, connected to the load by means of an equalizing bar through a single pin. Hoisting speed with a load of 40 to 50 tons is 30 ft. per min. and on loads of 1 to 40 tons, 120 ft. per min. The designed conveying speed

was 240 ft. per min. for all loads but since its installation this has been increased to 410 per min. with light loads. Adjustable voltage control is used for the three hoisting engines, a single motor generator set being used. The method of synchronizing the speed of the hoist motors is novel and is described in the article dealing with electrical developments beginning on page 586 of this issue.

Work at Bonneville and Columbia River Going Ahead Rapidly

Of the ten proposed developments on the Columbia River, two are being developed by the Federal government at the present time. Curiously enough, these are the first and last dams on the river. The Grand Coulee project, also known as the Columbia Basin development, is being carried on by the Bureau of Reclamation while the Bonneville Dam near Portland is being built by the War Department. Preliminary excavation work at the Columbia Basin dam is well under way, and work at Bonneville has gone forward so rapidly that bids have already been submitted for the initial two 60,000 kw. Kaplan type turbines. Ultimately there will be ten units. An interesting feature of the Bonneville turbines is that they will have about 30 per cent greater capacity than any Kaplan type now in operation. The effective head will vary from about 65 to 30 ft. At the latter head the turbines are expected to develop at least 28,000 hp.

Work on the Grand Coulee project is still in its very early stages, but this is the most extensive project yet undertaken, dwarfing even the Boulder Dam. When completed it will affect directly about a quarter of the state of Washington, bringing 1,200,000 acres under irrigation and supplying 8 billion kw-hr. annually. The dam will have a total length of 3430 ft. and will rise 450 ft. above the foundation and will back up the water 151 miles to the Canadian border. The dam will contain about 11,000,000 cu. yd. of concrete compared to the 3,400,000 cu. yd. to go into Boulder Dam.

Wheeler and Norris Dams Under Construction

The hydroelectric projects included in the Tennessee Valley development are less spectacular than those of the Columbia and Colorado rivers, but they are of extreme interest because in this development scarcely a foot of available power drop is unutilized. On tributaries and on the main stream, one dam toes against the one above, some 149 hydroelectric plant sites being available on some 3360 miles of river and tributaries. In addition to Muscle Shoals, which is already in, seven sites are available on the main stream. One of these dams, the Joe Wheeler Dam, 14½ mi. above Wilson Dam (Muscle Shoals) is now under construction. Its completion will double the firm power from Wilson Dam and offer an additional potential supply of some 172,000 kw.

The other large dam now under construction by the TVA is the Norris Dam at the junction of the Clinch and Powell Rivers. In many ways this is considered the key development on the system as the potential storage on these streams is some 23 per cent of the entire system. Work on this project also is considerably ahead of schedule. The preliminary work was completed early in the year and excavation work was extended into the bed of the river soon after underwaterway was completed. The pouring of concrete

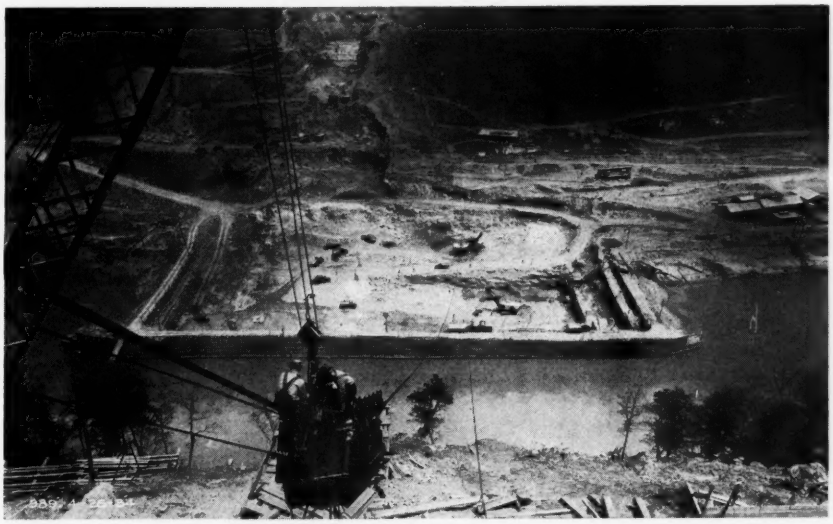


Fig. 5 (Left). A view at Norris Dam, showing cofferdam and preliminary excavation. This view was taken early in the year and at present construction is considerably further advanced. When completed in 1936 this dam 1800 ft. long, will create a vast reservoir 83 miles in area (Photo T.V.A.)

Fig. 6 (Below). Showing preliminary operations at Bonneville. Here they are excavating for the power house (Photo War Dept.)

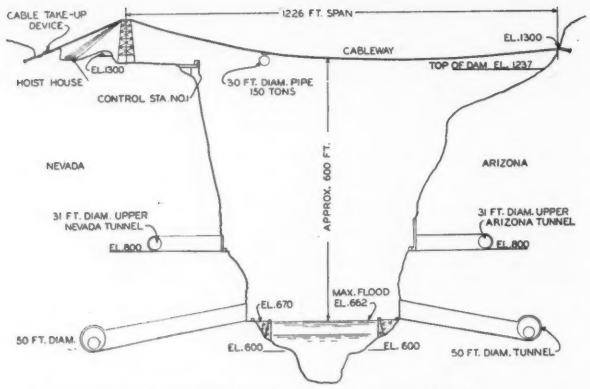


Fig. 7. Diagram of cableway across Boulder Canyon

began early in the summer and the first section of the two penstock tubes were set in place early in the fall. The Norris Dam plant will contain two 45,000 kw. generating units.

Rapide Blanc Started This Year

In Canada an important new plant that went into operation early this year was that known as the Rapide Blanc development of the Shawinigan Water and Power Co.'s system on the St. Maurice River. The first of six 36,000 kv-a. units was cut in in March and three more were started a short time later. This plant is 30 miles above La Tuque, Que., Canada, 180 miles north of Montreal. The construction of this plant involved unusual engineering difficulties due to its remoteness from civilization and the extreme weather conditions prevailing. Temperatures of 40 below zero were encountered and in the power house during the installation the temperature ranged from freezing to zero. To improve conditions where men had to work with their hands, electric space beaters were used with satisfactory results. The power house at Rapide Blanc is an integral part of the dam. The turbine units are of the Francis type.

Another far northern hydroelectric development placed into service this year was the Nivastroi hydroelectric station in Russia, the northernmost plant in Eurasia, well within the Arctic Circle. The first section of this plant was completed in June with the installation of a 20,800 hp. turbine while two more were added later in the year. This plant will deliver 92,000 kw. the year round as the swift flowing Niva River on which it is located remains open all winter. Its power will be used in mining operations.

The first of two 15,200 hp. Kaplan turbine units went into operation at the Vargon plant in Sweden early in the year. These machines, operating at 47 r.p.m. under a 14 ft. head, are noteworthy because they are the largest Kaplan hydraulic turbine runners thus far constructed, being 26 ft. 3 in. in diameter and weighing 150 tons.

New Roller Gate Dam on Mississippi

Although not a power development project, the dam across the Mississippi at Davenport, Ia., completed this year, is of interest because it is one of the few roller gate dams in this country. There are but five others, only three of which are completed. This construction had its inception in Europe, the first installation being made in 1901 and it proved so successful that to date some 300 installations are in use.

At Davenport, the dam consists of eleven cylinders or gates laid lengthwise, diagonally across the river, each of which can be rolled up to allow free passage of the river beneath it. Each main gate consists of a structural steel cylinder 109.25 ft. long and 19.33 ft. in diameter mounted between concrete piers, with each end sealed by a plate-steel end shield. Around each end of the cylinder is a cast-steel, toothed rim, the teeth of which engage in a cast-steel, toothed rack anchored to the lower side of an inclined recess in the pier. To

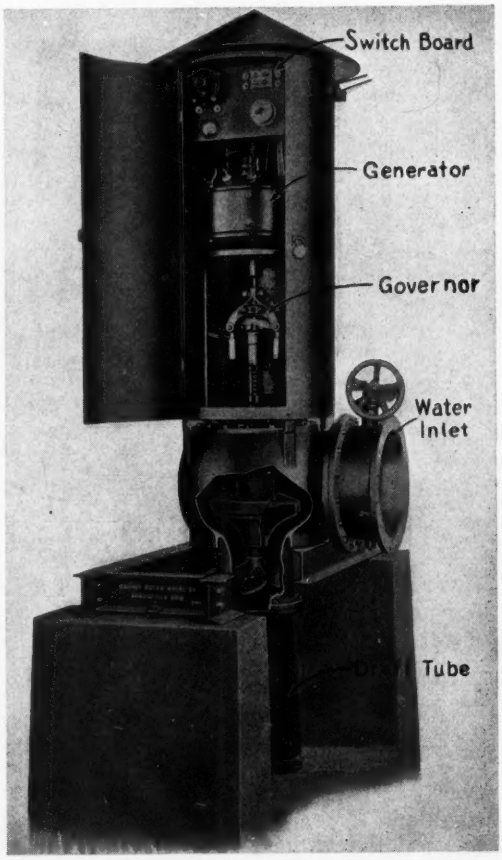


Fig. 8. Small self contained water wheel generating unit (Photo, courtesy The Hoppes Water Wheel Co.)

open the gate, the cylinder is rotated by a lifting chain at one end of the gate only, which is wrapped partially around and anchored to the gate cylinder. The completion of this dam this year marked the first step in the canalization of the upper Mississippi River and important Federal project in the development of the Middle West.

Transporting Hydroelectric Equipment by Airplane

Though the units involved were small compared to those we have been discussing, a hydroelectric plant constructed on the Island of Lae on the coast of New Guinea, this year, is of interest because of the method

of transporting the hydraulic and electrical equipment. This plant was needed to furnish power for the recovery of gold which had been discovered on the island, but the site proved rather inaccessible. The distance involved was not great but the terrain consisted of dense, nearly impassable, and cannibal infested jungle, together with a mountain range whose peaks rise to 13,000 ft. So it was decided to use airplanes. Heavy Junkers freight planes were used, having load limits of 7000 lb. Reducing the size and weight of the pieces of equipment presented a nice engineering job, but it was done. The four machines so transported were 875 kv-a. units, designed to operate at 600 r.p.m. The largest single pieces encountered were the generator stators which had a net weight of 6545 lb.

Turbine for Gas Charged Water

Although installed last year, an interesting hydroelectric installation was reported by Engineering of London in their Feb. 23 number this year. This unit, which was installed in South Africa by the Imperial Chemical Industries, is designed for a water supply of 477 g.p.m., under a head of 1700 to 1870 ft., the water containing in solution from 6 to 10 times its own volume of gas at normal pressure. This gas charged water is apparently the result of chemical processes accomplished under high pressure. The turbines are impulse units and the problem was to design a nozzle which would prevent the gas from being liberated and the water turned to spray before its energy was delivered to the buckets. As a result of theoretical investigations shapes were developed for the nozzle and the buckets which overcame the trouble, the pressure energy of the jet being converted into velocity energy and mechanical power so rapidly that the gas has not time to come out of solution. Another requirement of this installation was that the turbine had to discharge the mixture of gas and fluid to a height of 67 ft. This was met by maintaining the turbine casing under pressure, arranging the upper part always to be filled with gas which serves as a cushion to force the discharge to the required height.

Small Hydroelectric Unit

For use in developing small water power sites, a small compact hydroelectric plant was developed and placed on the market this year. This plant is complete and is designed to operate without batteries or other electric controlling apparatus. It consists of a vertical, propeller type turbine, direct connected to a vertically mounted electric generator, enclosed in a steel housing and mounted on an I-beam frame. It is available in sizes from ½ to 5 kw., and is equipped with a governor which regulates the speed of the water through a needle valve. The water passages are streamlined and there are no gates, links or columns to interfere with the flow. It operates under heads of from 8 to 21 ft. and is entirely automatic in its operation, requiring no further attention than occasional lubrication. This little unit has created considerable interest as there are many instances where a small, self-contained unit of this kind can be used to advantage.

A Christmas Impulse

ON THE DAY after Thanksgiving there appear throughout the land those bright little harbingers of the holiday season called Christmas Seals, which have become familiar to all of us as the means by which the 2000 affiliated tuberculosis associations of this country raise funds to carry on their work. This year they come to us not only with a plea for continuance of support; but in commemoration of one of the most important contributions to medicine ever made in this country, the picture of a little cottage, which, though seemingly insignificant, was the first sanatorium in the United States in which the modern treatment of tuberculosis was begun.

Dr. Edward Livingston Trudeau had cured himself of tuberculosis after discovering that the more he rested the better he felt. He had built at Saranac Lake, New York, and in February 1885 opened his little sanatorium for the treatment of others. In those days the Adirondack Mountains were a rugged wilderness paradise for hunters, so news of Dr. Trudeau's work seeped but slowly to the outside world. Eventually, however, the attention of the medical world was focussed upon him, and he was showered with honors. The idea soon had many disciples, and today, in contrast to his one room cottage with but two beds, there are in this country 659 modern sanatoruims, containing 86,917 beds. Trudeau showed how the disease, formerly considered practically a death sentence, could be cured by sanatorium treatment.

Organization of the National Tuberculosis Association in 1904 with the election of Dr. Trudeau as first president, marked the beginning of the nation-wide battle against the disease. Since then excellent progress has been made, but it is still a leading public health problem because it kills more persons between the ages of 15 and 45 than any other disease, taking its victims chiefly from among young women between 15 and 30 yr. of age and from working men between 15 and 45. With anticipation of Christmas, an impulse that is entirely appropriate to the season is to buy Christmas seals and help overcome tuberculosis.

Scaling is a turbine problem which is gradually assuming a degree of importance, comparable to the erosion problem. At certain temperatures some of the salt components of the carryover from the boiler become sticky and attach themselves to the blading. The process is cumulative and will continue, if unchecked, until the blade path is completely filled up.

One particularly difficult aspect of the turbine scaling problem is the corrosion of the blading and other parts, which is inevitable if a heavily scaled turbine is standing still a considerable part of the time. A satisfactory solution of this problem is to circulate heated air through the turbine during the stand-still so as to keep the deposits dry. The otherwise excellent 12 per cent chromium type of stainless steel is not impervious to the effects of ordinary salt (NaCl), which is invariably present in these deposits. This fact should be remembered in the choice of blade material.—C. R. Soderberg, W. E. & M. Co., before the N.A.P.E.

Research Most Dominant F

ELECTRICAL DEVELOPMENT

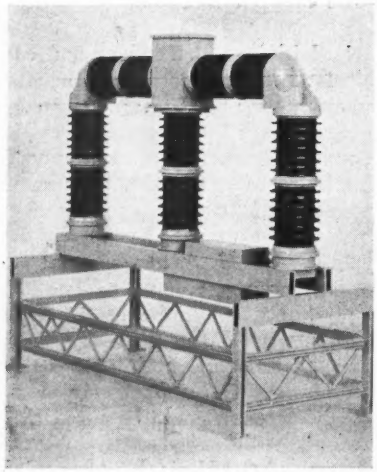


Fig. 1. Boulder Dam Circuit Breakers. (Photo, courtesy General Electric)

IN ATTEMPTING to present a review of electrical developments made during the past year, it is difficult to know where to begin. For the electrical field is not a separate thing as, for example, is the paper industry or the textile field; it is all-comprehensive and enters into nearly every human endeavor in civilized society. Developments in the electrical field, therefore, are not confined to those which result from fundamental discoveries in physics and from the natural evolution of electrical apparatus itself but also to those developments in the application and use of electricity in all other industries. Indeed, no small part of the total development in the electrical field in recent years resulted from the needs and requirements of other industries.

Despite the economic upheaval in which the world finds itself and the consequent decrease in commercial activity, electrical development continues at a rapid rate. In practically every branch of the field progress is so rapid that only a specialist in any branch can keep up with the development in that branch.

In all branches of the field, fundamental research continues to be an important factor in development. Our steadily increasing knowledge of electronics is opening up new lines of research and solving old problems in new ways every day. It is only when we really understand the fundamental processes involved in any device or system that we can intelligently improve that device or system. In the electrical field many discoveries were made more or less by chance, by cut and try methods or methods which were expedient and while the devices which resulted from these discoveries served their purpose it was not until we gained an accurate knowledge of the fundamentals involved in their action that we could improve them materially. And so today, research on fundamentals, adding more and more to our knowledge of electricity in general is furnishing the means for improving, sometimes revolutionizing, apparatus which we had regarded as practically perfect for years. It was research of the most fundamental nature of ionization phenomena a few years ago which radically altered our views regarding circuit breaker action and which resulted not only in improved types of circuit breakers but a number of other developments as well. In the same way fundamental studies in regard to the action and behavior of lightning surges have vastly improved our understanding of the design of transformers, transmission lines, insulators, etc.

Turning now to a specific consideration of this year's progress, we will discuss first development in the practice of generating electricity. Most of the activity in this field this year has been in the hydroelectric field. There have been some notable advances in steam driven generating units but they were less numerous than those made in the water driven units.

First, no doubt in point of interest, are the generators for the Boulder Dam Station which have been under construction during the year. These are the world's largest hydroelectric generators, rated at 82,500 kv-a. and designed to generate power at either 50 cycles, 150 r.p.m. and 13,800 v. or 60 cycles, 180 r.p.m. and 16,500 v. These generators are unique not only because of their large size but because of the special characteristics incorporated in their design to give them sufficient synchronizing power to keep in step under extreme changes of load. Each generator has a flywheel effect equivalent to 110,000,000 lb. at a one-foot radius which is about twice the flywheel effect which a generator of this rating of normal design would have. This is to prevent the speed of the unit from suddenly increasing when a short circuit occurs on a transmission line and thereby prevent the generator from getting out of synchronism with other rotating equipment on the system. They have a low inherent reactance—only 21 per cent and a high short circuit ratio, the latter being 2.4 or about twice the short circuit ratio found in a generator of normal design. These special electrical features increase the physical dimensions considerably, these units being as

Factor in

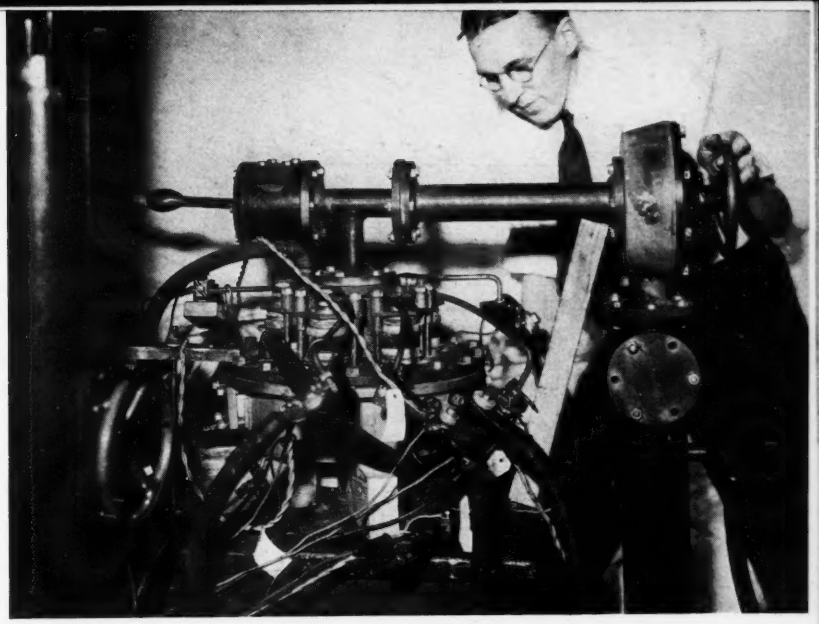


Fig. 2. Experimental 6 phase Ignitron delivering 300 A. at 300 v. (Photo, courtesy Westinghouse)

large as 125,000 kv-a. machines of normal design. The units are 40 ft. in diameter, 32 ft. high above the floor level and each machine weighs approximately 20,000,000 lb. Four of these units are now under construction, two by Westinghouse and two by General Electric. A 40,000 kv-a. unit is also under construction by Allis-Chalmers.

Another important unit featuring this year's progress is the large, single-phase, water-wheel generator now under construction for the Safe Harbor plant on the Susquehanna River. This is a 25-cycle unit rated at 35,000 kv-a. 13,000 v. at 100 r.p.m. and while its construction involves no unusual features it is interesting because it is the largest single phase generator ever constructed. Power generated by it will be transmitted at 132,000 v. to the high-tension lines of the Pennsylvania Railroad at Perryville, Md., for use on their newly electrified divisions. The use of this machine is rather unusual. The locomotives on the system require 25 cycle single phase power. Usually the power is generated by three phase 60 cycle generators and changed to 25 cycle single phase current by frequency converters. In this case, however, with the new generator, the conversion losses which average more than 5 per cent will be saved.

With the exception of the 183,333-kv-a. generator being built for the Richmond Station of the Philadelphia Electric Co., and the 80,000 kw. unit for Port Washington, both of which were mentioned in our review last year, no new very large steam driven generators were built this year. An outstanding feature of interest, however, was the purchase by the Ford Motor Co. for installation in the River Rouge power plant, another 110,000-kw. turbine generator, of the vertical compound type similar to the 110,000-kw. unit installed in the same plant in 1930. Although the general design of the generator will be the same as that of the 1930 unit, the turbine design will differ in a number of respects. It will be the first large unit to operate at 1200 lb. and 900 deg. temp. and will be of more compact construction. Air coolers will be built integral with the generators and will be connected so that the heat losses in the generator will be recovered by the feedwater. Like the first unit. it will be a cross compound machine, each generator having a rating of 55,000 kw. at 1800 r.p.m.

The construction of the Richmond generator has been going on throughout the year and will be delivered in 1935. An extremely interesting feature of this generator was the assembling of the rotor[1]. The huge center bolt weighs six tons, is 13 in. in diameter, 310 in. long and is forged from nickel molybdenum steel. It is believed to be the largest bolt of its kind ever made. The plates which make up the rotor were drawn over this center bolt. After they were in position, four 6 in. bolts were pushed through holes surrounding the center bolt hole, by hand. Naturally, perfect positioning was necessary to allow the bolts to pass through because there was less than 0.006 in. clearance. These bolts hold the plates between two heavy forgings. In the work of assembly, a hydraulic bolt puller exerting 1,500,000 lb. pull, and stretching the bolts $\frac{3}{8}$ in. was used, as the nuts were turned by hand. Steam was passed through a hole in the center bolt during this operation so as to give it the same elongation as the side bolts.

Representing engine driven units, the 19,000-kw., 3-phase generator to be driven by the world's largest Diesel engine at Copenhagen marks another step forward this year. This unit is for the Copenhagen Municipal Power Station and was constructed at the Västeras plant of the Swedish General Electric Co.

While development in the electric motor field has not been marked by anything of a spectacular nature, many improvements were made during the year, particularly the smaller size motors. There has been considerable development of motors for special purposes, such as for example the "lead pencil" type used for oil well bottom pumps[2]. The design of this motor represents a high degree of engineering achievement for it was no small order to build a highly efficient 97 hp. motor with a diameter of less than 8 in. and capable of being dropped a mile or so beneath the surface of the earth in drill holes. Yet, this difficult task was accomplished, and accomplished well, for these motors have proved very successful in the Okla-

[1]Power Plant Engineering, July 1934, p. 418.
[2]Electrical World, May 19, p. 731.

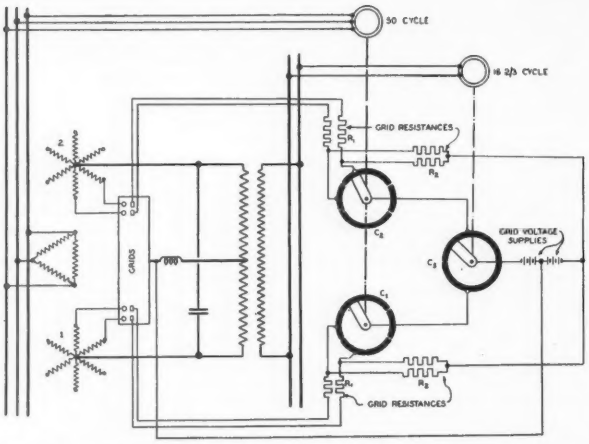


Fig. 3. Static converter which couples 16⅔ and 50 cycle systems

homa oil fields. The unit includes motor, strainer and a 135 stage centrifugal pump all in one casing.

Several new "gearmotors" were developed during the year and where silence and freedom from vibration are essential requirements further use was made of rubber in the design of motor mountings. Motors apparently can be designed for almost any conditions which may be demanded. This year a small size motor was built capable of as many as 100 reversals per second. The question of noise in motors is being attacked not only by means of rubber mountings but also by more fundamental methods. The importance of using regular windings in polyphase wound induction motors in eliminating harmful effects on efficiency, power factor and noise, was pointed out in a paper before the A.I.E.E. by Hellmund and Veimott,[3] and in which the Georges diagram of tooth fluxes was presented for studying this phenomenon.

Transformers and Converters

In the field of converting equipment, a notable job this year was the construction of a 6000 kw. motor generator set for the new blooming mill at the Ford Motor Co. This set, used for the 7000 hp. steel mill motor also being built for this same mill, has a flywheel weighing 146,800 lb. It consists of two 3000 kw., 750 v. generators, a 5000 hp., 13,200 v. induction motor and flywheel. All this equipment has been under construction this year.

There were no unusual developments in transformer practice during the year, but the problem of improving transformers has received considerable study. One step in the direction of improved design this year was the development of a reactance model for analyzing reactance formulas experimentally. This consists of a power transformer core and coils constructed on a small scale so that various sizes of coils and core openings may be assembled and tested experimentally. It is to the design engineer what the calculating board is to the transmission engineer.

The eleven power transformers ordered for Boulder Dam are of interest since the seven largest ones are rated at 65,000 kv-a. at 287,000 v., the highest commercial voltage of any transformer built in the United States. The larger units will be water cooled, will weigh over 500,000 lb. each and are approximately 35 ft. high, 19 ft. wide and 20 ft. deep. The four smaller ones are rated at 13,333 kv-a. at 138,000 v. and are forced oil cooled.

In Switzerland this year there was developed a new static converter for coupling a traction and a power system, which it is claimed has many advantages. This development uses a grid controlled mercury arc rectifier and converter to give flexible frequency coupling between a 16 2/3 cycle railway and a 50 cycle power supply. No rotating equipment of any kind is involved. As evolved and reported in the Brown Boveri Review for June 1934, it meets the requirements that an adjustable amount of energy shall be exchanged in either direction, independently of any variation in the frequency ratio. It does this at good efficiency and with minimum distortion of the voltage wave of either system. The advantages claimed are: symmetrical loading of three phase network, high efficiency sinusoidal single phase voltage, perfect flexibility, direct conversion in a single stage, simple starting, elimination of all synchronizing equipment, good three phase power factor, advantageous utilization of the valve and automatic power regulation. Tests on a 200 kw. experimental unit have confirmed these characteristics.

Of unusual interest were the demonstrations of the first high voltage grid-controlled steel rectifiers made in the United States in May of this year at the Allis Chalmers Mfg. Co. in Milwaukee.[4] This tube with an output voltage of 25,000 v. d.c. delivers 1000 kw. of direct current power and is intended for use with high power broadcast transmitters. The arc drop, it is claimed, is so small that it can be operated at more than 99.9 per cent efficiency. An outstanding feature of this tube is that it can automatically cut off the power in less than one cycle to clear a flashover or similar fault, and can replace the power in less than 1/10 of a second after the interruption. The direct current output is adjustable to any value between zero and maximum by the control circuit of the tube itself. Although this high voltage, grid-controlled rectifier is the first one to be built in the United States, about three dozen have been made by the Brown Boveri Co. in Europe. Eleven of the high power radio stations in Germany are using this type of rectifier.

[3]Electrical Engineering, Feb. 343.

[4]Electrical World, May 19, 1934, p. 732.

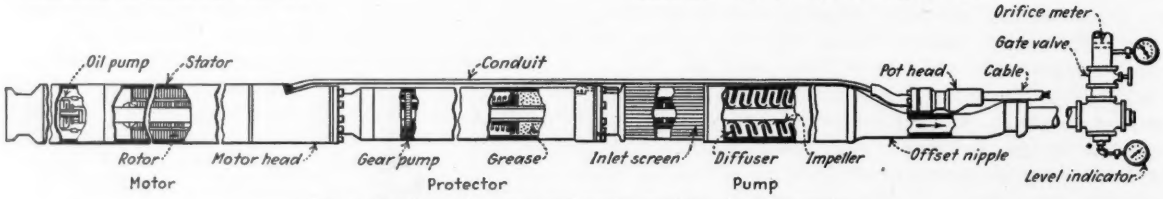


Fig. 4. Lead pencil motor and pump used in oil well pumping

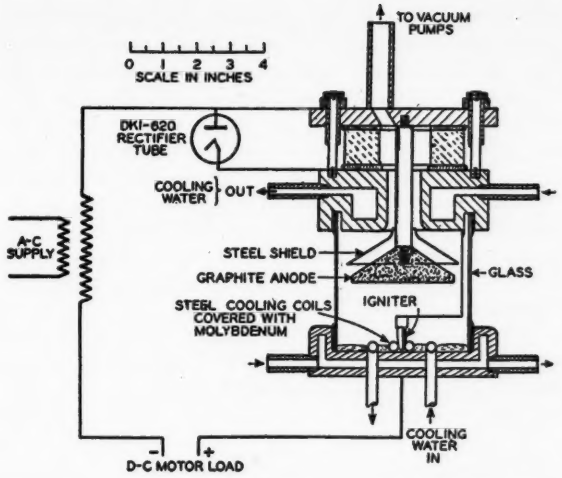


Fig. 5. A single anode experimental ignitron. (AIEE—Jan., p. 76, Fig. 1)

The "Ignitron" principle developed by Slepian last year, found application in experimental ignitrons of both the polyphase types and in the commercial development of ignitron welding timer for spot welding. In spot welding it is necessary to control the duration of the welding current within very accurate limits. In this welding timer, two ignitron tubes operate in conjunction with three grid glow tubes. The latter furnish controlling current to the ignitron electrodes of the ignitrons. Once the ignitrons are rendered conducting they continue passing current until the next succeeding zero of welding current. The timing adjustments are so set as to cause the "stop" timing tube to operate during the last desired half cycle of welding current.

A high power welding rectifier of this type is the latest development in this field[5]. This, of course, is similar in principle to the small units referred to in the preceding paragraph but it is constructed of steel instead of glass. At present five of these units are in commercial operation, 1 welding stainless steel beer barrels, 1 aluminum beer barrels and 3 bronze refrigerator evaporators. One of these uses a 50 per cent duty cycle with a peak current of 500 amp. Another uses a 23 per cent duty cycle with 1600 amp. peak and 120 amp. average per tube. All have given several months of satisfactory service.

The experimental ignitron rectifier referred to was designed in an effort to produce a rectifier which would be free from backfire and at the same time have a simple "low drop" arc[6]. The single phase unit which was first constructed consisted simply of a graphite anode placed above a mercury pool cathode. The arrangement is shown in Fig. 5. The igniter was connected to the cooled upper plate which was connected electrically to the anode through a rectifier tube. This unit was tested in a single-phase, half-wave rectifier circuit and the output direct current power was supplied to a rotating machine. Later a slightly modified design was made which with an average of 75 amp. and 600 v. d.c. under 15½ hr. of operation was subject to only three backfires. A subsequent 6 phase model was built along the same line which operated with no backfiring. This development in the rectifier field is of considerable importance as the problem of backfires has seriously hampered the design and this principle seems to point a way out.

An interesting development in small rectifiers was seen this year in an electronic rectifier built for testing radio transmitting tubes. This set had to supply filtered direct current at any voltage from 50 to 5000 v.; had to hold voltage at any set point within 1 per cent regardless of supply voltage fluctuations up to 15 per cent and load current variations up to 2 amp. full load; had to have a feature capable of limiting the current output to any value from 1 amp. up, even on short circuit without affecting the voltage regulation up to the current limit; the operation of the set was to be as simple as possible; it was to have a high order of reliability and be constantly available; and finally the completed unit was to fit into an existing space 4½ by 2½ by 3 ft. It must be admitted that these were severe requirements, yet they were completely met by a hot cathode mercury vapor rectifier set of conventional design, the primary voltage of which was controlled by saturable reactors with vacuum tube control. The system involved is unusual and is capable of a wide variety of applications and high precision of control. A diagram of it is shown in Fig. 7.

Another development in recitifier practice which came from abroad are large-capacity, steel-cylinder, mercury arc rectifiers without vacuum pumps or water cooling. At the time it was reported in the Elektrotechnische Zietschrift one of these units had been operating for over 6 months without loss of vacuum. These rectifiers are produced by heating the welded steel cylinders to a temperature during the evacuating process. This drives the occluded gas in the walls of the vessel out in the same way that it is driven from the walls and internal elements of ordinary vacuum tubes in the process of manufacture. It was found however that even with this treatment, if the unit was cooled with water, a gas analysis would show pure hydrogen to be present after several hours. It is thought that hydrogen in atomic form diffuses through the walls of the tank. Therefore, a cooling medium not containing hydrogen was tried and this proved successful.

Transmission and Distribution

Of interest to transmission engineers the world over was the completion in April of this year of the "British Grid." This is the national network of transmission lines and generating stations in England, the development of which was started in 1927 under the electricity-supply act. It is claimed to be the first and far greatest example of concrete planning of a national utility service in any country in the world. As now operating, the network includes approximately 4000 miles of transmission lines, 3000 miles of which are operating at 132 kv., the remainder at 66 kv. or less. The number of generating stations for public supply with this system has been reduced from 500 in 1927 to 135 at present.

The grid suffered a serious breakdown on July 29 when trouble developed at the Battersea station in London and the whole of the export of that company

[5]Electric Eng. Oct. 1934, p. 1380.
[6]Electrical Engineering, Jan., p. 76.

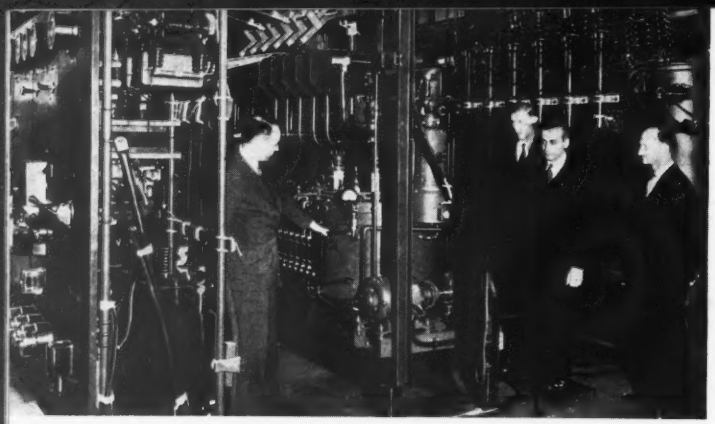


Fig. 6. Engineers observing test of grid controlled rectifier. (Photo, courtesy Allis-Chalmers)

to the grid system of southeast and east England was interrupted. It happened on Sunday and owing to the reduced demand fewer stations were available to take up the load. As a consequence some sections were without power from a half hour to nearly four hours.

In point of magnitude, the construction of the 287,000 v. transmission line from Boulder Dam to Los Angeles is the most notable event in the transmission field in this country, this year. Though this line is not yet completed, construction work is going forward rapidly. This line will operate at the highest transmission voltage ever used, and will carry power 270 miles. The line consists of two steel tower lines spaced about 300 ft. apart and each carrying a single 3-conductor circuit, with the towers spaced about 1000 ft. apart. The spacing between the outer conductors on a given tower is about 65 ft.

An interesting feature in the construction of this line is the provision of a counterpoise and the method of laying it. This is accomplished by a specially designed plow, towed by two tractors and carrying a reel of from 4000 to 5000 ft. of wire. It lays an average of 1½ miles of wire per hour and operates successfully in sand, hardpan, shale and extremely rocky terrain.

The question of counterpoises for protecting electric power transmission lines against damage from lightning surges is one that has received considerable discussion recently. For it seems that the problem of protecting transmission lines against direct strokes of lightning is related intimately to the earth conditions of the right of way over which the line passes. The counterpoise, consisting of cables connected to the line towers and buried in the ground offers a solution to the problem. Two types of counterpoises have been developed, one the "crow's foot" consisting of cables extending radially from the corners of the towers; and the parallel type consisting of cables extending from the towers parallel to the line. The question received considerable discussion at the winter meeting of the A.I.E.E. and while the desirability of the counterpoise seems to be generally agreed upon, there is considerable difference of opinion as to the theory and method of calculation. On the Boulder Dam to Los Angeles transmission line 4 counterpoise cables are being buried, two under each circuit spaced 130 ft. apart[7]. At each point where the towers are adjacent, a buried cross tie connects the towers. Where possible, the counterpoise wires are brought in from their normal spacing to each tower base at an angle of 45 deg. and connections made to the tower. Thus the advantages of a "crow's foot" or radial counterpoise is obtained by the four continuous wires and the one cross tie leaving the tower base, while the wire being continuous prevents any positive reflections of voltage from open. There are some who feel that the theory upon which this particular system is developed is too liberal, giving better protection than will be found in practice. It will be extremely interesting to watch the performance of the Boulder Dam-Los Angeles line in this respect.

[7]Electrical Engineering, March, p. 468.

While commercial developments have not been numerous, study of all aspects of transmission line practice has continued and many improvements have been made. Research in suspension insulator design

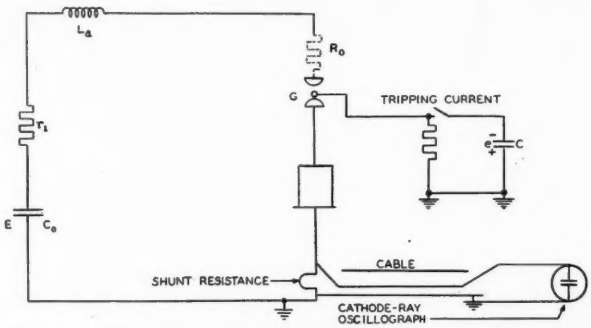


Fig. 7. Schematic diagram of component parts of vacuum tube controlled rectifier set

for example has resulted in an increase of from 6000 to 11,000 lb. in load carrying ability[8]. A new porcelain post insulator also was developed which is free from radio effects at its operating voltage, and has improved arc resisting characteristics. The question of radio influence insulator characteristics has received much attention and methods have been developed which reduce it in existing insulators. This consists of treating the insulators with special compounds to exclude air. For new insulators a copper oxide glaze has been developed[9].

Lightning Research

Work in surge generator design this year has been more in the direction of high current than high voltage. A rather spectacular achievement in this direction was the development of a surge generator at the General Electric plant at Pittsfield producing a current of a quarter of a million amperes[10]. This current, at 100,000 v., produced the same destructive effects upon various materials placed in its path that natural lightning does. Though these discharges take place in about .8 microseconds, the energy release is at the rate of 30,000,000 kw.! While these effects are of spectacular interest, this equipment will be used in connection with the testing and design of high tension equipment. Along similar lines at Westinghouse, currents of over 210,000 amperes turned flat copper strap into copper tubing purely by the mechanical magnetic effect.[11]

[8]Electrical Engineering, June, p. 867.
[9]Electrical Engineering, June, p. 899.
[10]Power Plant Engineering, Sept., 425.
[11]Power Plant Engineering, Nov.

These high current surge generators are comparatively simple and extremely compact when compared to the high voltage surge current generator. The circuit of the surge current generator at the Westinghouse laboratories at East Pittsburgh is shown in Fig. 8[12]. It consists of a set of static condensers, grouped in two banks of ten units each, an arrangement that makes it possible to operate the generator at 100,000 v., 4.8 microfarads, or as two stage generator at 200,000 v., 1.2 microfarads. This is arranged as shown in series with suitable resistances, inductances and sphere gaps, the latter involving a tripping arrangement. This consists of a middle sphere connected to a tripping condenser, which when properly set can cause the breakdown of the main spark gap at any instant.

It is interesting to know that the currents generated by these surge generators are higher than those encountered on transmission systems due to lightning. In a comprehensive study of lightning arrestor currents, out of 499 measurements, only one discharge occurred with a maximum of 34,000 amperes.

A new laboratory for high voltage testing at the Ohio Brass Co. at Barberton, Ohio, was another development of importance this year. In this laboratory a new form of 3000 kw. impulse generator is used in which size, inductance and stray capacitance have been reduced to a minimum by a helical arrangement of capacitor units[13].

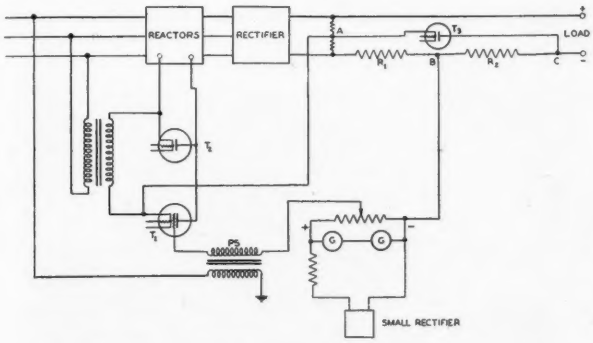


Fig. 8. Diagram of high amperage surge current generator

More and more accurate measurements are being made of actual lightning phenomena by means of instruments. The cathode ray oscillograph, the Klydonograph, the surge crest ammeter have all undergone refinement and improvement. A recent investigation into the behavior of the Lichtenburg figures on glass plates by J. Gibson Pleasants at the California Institute considerably extended our knowledge of the formation and characteristics of these interesting figures[14]. One operating company, the Milwaukee Electric Railway and Light Co., now checks all major faults on their transmission lines and equipment by automatic oscillographs. At the Buffalo, Niagara and Eastern Power Corp. the development of a shunt filter circuit, prevented needless operation of automatic oscillographs and consequent waste of photographic paper. Before the installation of this filter, ordinary switching operations often set the automatic oscillographs in action.

[12]Electric Journal, March, p. 96.
[13]Electrical Engineering, Sept. 1934, p. 1255.
[14]Electrical Engineering, Feb., p. 300.

The surge crest ammeter has recently been greatly improved in design by the development of the magnetic link principle. With this instrument the retained magnetism of a magnetic link after its subjection to the magnetic field of the surge current, is the permanent record of the intensity of the surge[15].

A new tool in the investigation of natural lightning is the Boys camera in which a film is whirled past the lens at a mile a minute, thus providing a time scale along the length of the film in millionths of a second[16]. By photographing lightning strokes with this camera it has been shown that the average lightning stroke is a multiple affair, in some instances as many as 10 recurrent discharges over the same path.

Better Looking Distribution Lines

In distribution line practice, an admirable movement on the part of certain operating companies is the improvement in the appearance of distribution pole lines and structures. In recent years much has been done to improve the architectural appearance of substations, but little or nothing has been done toward eliminating the unsightliness of the average pole line. Recently, however, a distinct effort has been made on the part of one company at least, to use more ornamental designs of cross arms, more uniform and better looking transformer installations, more pleasing insulator groupings, etc. It is to be hoped that this movement will be continued for though people do not buy distribution lines they are compelled to look at them, so why not give a little thought to their appearance[17]?

Circuit Breakers and Switching Devices

Like everything else involved in the Boulder Dam project, the circuit breakers to be used on 138 kv. and 287 kv. transmission systems are unusual, and of an entirely new design[18]. These high voltage impulse breakers are notable because of their extreme speed of operation and their low oil content. Only 96 gal. of oil per pole are required by a breaker with an interrupting rating of 1,500,000 kv-a. at 138 kw. compared with approximately 1700 gal. per pole for a conventional breaker of an equivalent interrupting rating. Horizontal containers not much larger than conventional bushings enclose the interrupting mechanism.

[15]G. E. Review, July, p. 324.
[16]General Electric Review, July, p. 349.
[17]Electrical World, April 21, p. 574.
[18]Power Plant Engineering, April, p. 200.

Fig. 9. Assembling first Boulder Dam generator. (Photo, courtesy General Electric)

Fig. 10. Application of photocell in protecting operators from high voltage test set in laboratory. (Photo, courtesy Westinghouse)

These containers are mounted on vertical central supports which in addition to serving in an insulating capacity also house current transformers when required. The interrupting elements consist of several sets of contacts in a line and the inside of each container is so arranged that oil driven by a piston is positively directed across the arc path of each of the several arc breaks per pole during circuit interruptions. Tests on these units indicate that they will interrupt the current in approximately three cycles.

Eight breakers of this type rated at 287 kv. are under construction for the Boulder Dam line. They will have a total of eight breaks in series and are designed to break the current in three cycles.

As a development which may affect circuit breaker design, the action of the grid controlled mercury arc rectifier described previously is important, for it has been demonstrated that with a device of this type circuits may be interrupted noiselessly and without the slightest electrical disturbance to the circuit.

The range of high speed air circuit breakers increased to a 10,000 amp., 750 v. d.c. continuous rating, these units being particularly adaptable to 600 v. railway service. In small circuit breakers, the development of an "arc arrestor" improves performance in suppressing the arc considerably. This unit consists simply of a small capacitor and resistor connected across the poles of the contacting device, and may be adapted to any contactor. Oscillograms show less than one-half cycle of arcing with the arc arrestor as against a persistance of 5 to 8 cycles under otherwise identical conditions.

There has been considerable progress in the development of small switches or contactors, most of them using the vacuum break principle. The glass walls which characterize the earlier models of this type switch has now been supplemented by units made of metal. One unit of this kind, this year it was reported, operated 10,900,000 times under full rating of 15 amp. at 250 v.

For existing circuit breakers, not equipped with reclosing mechanism, a new mercury reclosing device has been developed[19] which can be attached to any breaker already in service. It consists of a base and corer, a timing element which also contains a circuit closing electrical contact, an operating mechanism and a resilient coupling terminating in a bell crank. The latter permits connection to some part of the circuit breaker moving through a specified distance in either a vertical or horizontal direction. It is applicable to air or oil circuit of either the indoor or outdoor types.

Development in electrical control equipment is so rapid and so diverse that it is difficult to present a general review of the situation. The automatic principle is the one great difference between the machine age of today and the machine age of twenty years ago. Today nearly everything can be done and be done better and faster by automatic equipment than by manual control and the automatic principle is being applied to everything from the control of volume in a radio receiver to the fabrication of automobile bodies.

In the power field proper the element of control enters into every part of the system from the control of fuel or water power to the system at one end to the control of the system as a whole at the other. The control of load and frequency, of stability, of fault currents of large systems for example is receiving increasing attention and new devices and systems for attaining this control are constantly being developed. Quite recently Robert Brand of the New England Power Engineering and Service Corporation of Boston in discussing the total load on the New England and New York interconnected power systems, pointed out that the frequency of such a system should be kept constant within a variation of plus or minus 1/20 of a cycle. This seems close, yet recorders are available today which respond to changes in frequency as small as 1/100 of a cycle. This is significant of the trend.

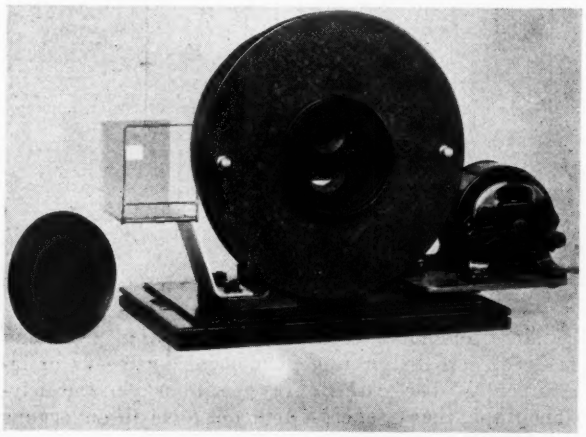


Fig. 11. Boys camera used in photographing lightning flashes. (Photo, courtesy General Electric)

As an unusual example of development in control consider the breakdown of a sphere gap under high potential. This normally is a function of the ionization of the air and since this varies in different places and under different conditions, the action is somewhat erratic. The development, however, of a simple device this year, merely a ring the inside of which carries a coating of radium and which is placed around the spark gap, has placed this ionization of the air under control[20]. As a result, a sphere gap so equipped is much more accurate in its action.

[19]General Electric Review, Oct., p. 462.

[20]Electric Journal, March, p. 101.

This year, as in the previous one, the thermionic tube and the photocell have been incorporated in numerous control devices. Of considerable importance is a new compensated automatic synchronizer—a relay for automatically synchronizing rotating machines which uses vacuum tubes to reduce mechanical adjustments and which gives the closing indication at a constant time in advance of synchronism[21]. This instrument incorporates insulating transformers, compensating rectifiers of the copper oxide type, filters and vacuum tube amplifiers and relays. It compensates for breaker closure and is extremely accurate and rapid in its action.

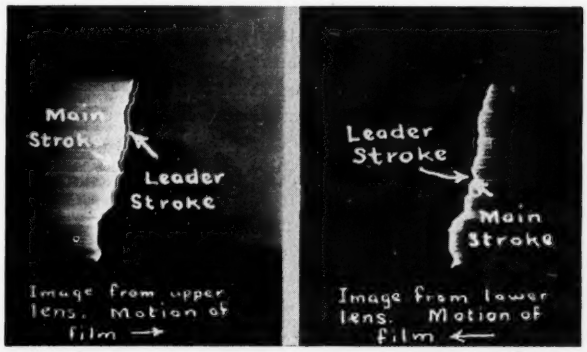

Main Stroke
Leader Stroke
Image from upper lens. Motion of film →
Leader Stroke
Main Stroke
Image from lower lens. Motion of film ←

Fig. 12. Photographs taken with Boys camera. (Photo, courtesy General Electric)

Among several new types of voltage regulators developed recently those using thyratron tubes are of particular interest. In one instance reported by G. G. Kretschman of the physics department of Walla Walla College, a thyratron tube regulated the voltage of a 90 kv-a. alternator. This system is comparatively simple, the voltage sensitive element being two 16 candle power carbon lamps and two 40 watt tungsten lamps arranged in opposite legs of a Wheatstone bridge circuit. Two corners of this bridge connect across the line circuit and the other two through a suitable transformer to the grid filament circuit of the thyratron tube. The direct current output of the thyratron is applied across the exciter field rheostat thus regulating the voltage of the generator.

At the Southern California Edison Co. a still simpler voltage regulator was developed, for the purpose of regulating the voltage of a battery charging motor-generator[22]. This regulator consisted of only a thyratron tube in combination with a transformer and several resistances. Its application eliminates field adjustment and stabilizes voltage on low saturation points thus relegating to the discard one of the familiar and forgotten chores of substation operation.

A more developed and more sensitive voltage regulator is one recently developed by Westinghouse which provides regulation of a.c. generator voltage within a range of 1/10 per cent. Oscillographic tests show that the speed of response of the electronic type regulator is higher than that obtained with the best of the electromagnetic type of regulators. In fact, the performance and reliability of the electronic type voltage regulators have been so satisfactory that it seems safe to predict that electronic type voltage regulators will find wide application in the industrial and central station field.

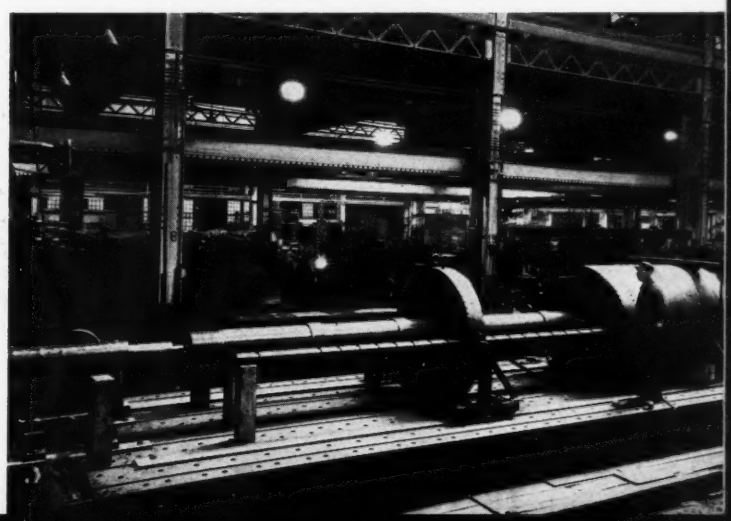
Supervisory central system and systems of telemetering have undergone several new developments which have extended their application. Among the former, the Polaricode Junior is an interesting development. This is a simple, inexpensive, standardized equipment which incorporates all the necessary control and supervision for small stations in which there will be no future expansion. It uses the same principle as the standard polaricode system but is a smaller more compact unit.

Industrial Application of Synchro-tie Principle

The synochro-tie principle used in the Selsyn system although having been applied first only for duplicating meter readings has a much wider application and has found an amazing variety of applications all the way from transmitting meter readings to keeping a lift bridge level as its ends are elevated. An important application of Selsyn control made recently is in the synchronizing of the two large direct current drive motors on the great cableway across Boulder Canyon. With this control one hoist motor is used as the master and the other is regulated to conform to its speed. To accomplish this a Selsyn generator is driven by each hoist motor. Each Selsyn generator is connected electrically to a differential Selsyn. Such an arrangement is analogous to a mechanical differential. When the Selsyn generators operate at exactly the same speed the shaft of the differential machine remains stationary. Should one drive operate at a different speed, the shaft of the differential rotates and adjusts the regulated motor field, changing its speed to conform to the speed of the master hoist motor.

Many new applications of the photoelectric cell were made during the year. One that is being used more and more is in register control on wrapper, bag or package making machines. An extremely novel use of the photocell was in protecting the operators at a high voltage testing laboratory. By means of a light source with suitable condensing lenses and a system of mirrors together with a photocell, a "fence" of light was formed around the high voltage equipment.

Fig. 13. Assembling the rotor for the Richmond generator. (Photo, courtesy Westinghouse)



[21]Electrical Engineering, June, p. 960.
[22]Electrical World, Aug. 25, p. 243.

If the beam was interrupted by the operator's body approaching too near the high voltage equipment the relays automatically cut off the power supply.

Another interesting application of the photocell this year was in the control of daylight at a new post-office at High Point, N. C. To prevent glare, louvers were placed directly over the skylights. A photocell

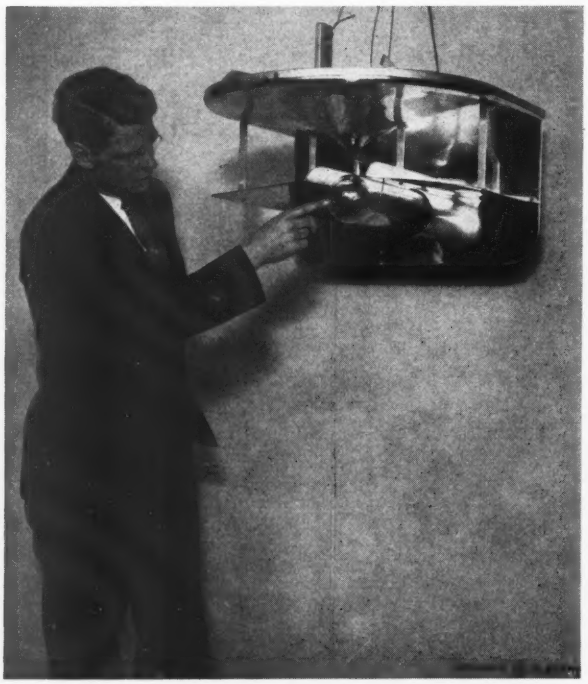


Fig. 14. New Sodium Vapor Lamp. (Photo, courtesy General Electric)

placed on the inside of the building operates these louvers so as to maintain a predetermined amount of daylight at all times.

It is impossible in a general article of this type to review even superficially the many developments and applications in vacuum tube practice. Several of them have already been touched upon in preceding paragraphs but there are scores of others. The thermionic tube, particularly the gas filled type, is gradually revolutionizing the entire field of control. Of considerable interest in this respect was a paper in the October number of Electrical Engineering by Rolf Wideroe of Oslo, Norway, in which he described a number of new grid controlled, gas filled tube relays for the protection of transmission lines. These included over current, under voltage, under impedance, power directional, distance and many other types of relays all of which have been developed and tested at the A.E.G. relay factory in Berlin.

Developments in Illumination

The year has brought forth many developments in illumination practice, particularly in the field of high intensity units of the gaseous discharge type. It is only a few years since the first successful experimental sodium vapor lamp was produced, yet today a considerable number of them are in commercial service. The sodium vapor lamp has not only proved a new tool of value to the illuminating engineer but it constitutes the most significant advance in lighting efficiency that has been made in many years. In the development of gas filled incandescent lamps it had been found that even if krypton should become obtainable at an economic price, a gain of only some 20 per cent in efficiency could be expected. Now with the successful development of a glass which will resist attack by hot sodium vapor, a theoretical efficiency more than 25 times that of the average Mazda lamp becomes possible. Last year the Balltown Road near Schenectady was equipped with a sodium vapor lighting system which demonstrated the practicability of the sodium vapor lamp. This year the original installation was replaced by a new improved system using new lamps. These are 10,000 lumen a.c. sodium lamps in specially designed luminaires operated in series with a current of 6.6 amp. The newer lamps are higher in efficiency in lumen output and have more effective distribution of light.

The development of the sodium lamp has stimulated research upon other types of gaseous discharge lamps, and this year saw the installation of 600 high pressure mercury vapor lamps in combined mercury vapor tungsten lamp fixtures at the Ford Building at the 1934 Century of Progress. These lamps are rated at 15,000 lumens with 400 watt consumption. Two such 400 watt lamps and three 500 watt tungsten lamps were combined in one fixture to give approximately daylight illumination. Several types of high pressure mercury vapor lamps were produced this year capable of operating directly from 115 v. circuits.

The 1934 Century of Progress at Chicago presented what was perhaps the most spectacular illumination effects ever produced anywhere, a vast improvement over the 1933 displays in fact. An outstanding feature was the great electrical fountain, using 68,000 gal. of water per minute and over 507 kw. for lighting alone. All the electrical buildings at the Century of Progress, a laboratory model of a 100 kw. incandescent lamp was displayed. This lamp was over a yard high and had had glass walls ¼ in. thick.

Though insignificant when compared to 15,000 lumen sodium vapor lamps and 100 kw. incandescent lamps, a nevertheless important development in lighting this year was the production of multiple burning Christmas tree lamps. These will save much time and effort heretofore spent in locating burned-out series lamps.

Communication

No branch of the electrical field perhaps has been characterized by greater development in recent years than that devoted to communication systems, not only for the transmission of intelligence but also for control purposes. Some of the latter have already been mentioned. The principles of "radio" and the continual development of vacuum tube equipment have produced innumerable new devices and systems for the improvement of communication circuits.

The so-called "Auditory Perspective" system referred to in our review last year was demonstrated at the winter meeting of the American Institute of Electrical Engineers and its technical features des-

cribed. This is a most amazing development and its application in the future makes possible the perfect transmission of sound in all its aspects.

Another development of great importance was the design of a stabilized feed back amplifier. When many amplifiers are worked in tandem it becomes difficult to keep the overall circuit efficiency constant, with the result that the amplifiers become unstable and extraneous frequencies are generated which interfere with parallel circuits. However, by building an amplifier whose gain is made deliberately, say 40 decibels higher than necessary (10,000 fold on an energy basis) and then feeding the output back to the input in such a way as to throw away the excess gain, it has been found possible to effect extraordinary improvement in constancy of amplification and freedom from non-linearity. This is the principle of the stabilized feed-back amplifier[23].

Fig. 15. Arc Arrester improves contacts. (Photo, courtesy Westinghouse)

The need for wider frequency ranges in our communication systems led to the development this year of a wide band transmission system coaxial lines. This system employs a specially constructed cable consisting of an inside solid conductor surrounded by an outside conducting sheath. With these conductors, systems capable of transmitting frequency banks 1000 kv. or more are attained[24].

In transoceanic radiotelephony a notable achievement announced this year was the development of the "Compandor" a system to suppress the interfering effects of static. While this is a rather complex device it is an automatic arrangement compressing the range of useful energy variations at the transmitting end and expanding the range to normal at the receiving end thus greatly improving the speech-to-noise ratio[25].

Of interest to those operating communication circuits over power lines by means of carrier current, two outstanding improvements were the development of an automatic volume control system and a means for interconnecting the carrier circuits with two wire telephone facilities. In addition much has been achieved in lowering installation and maintenance costs and improving the reliability of operation of such systems.

Carrier current has also been adapted to operating switches controlling electric water heaters using off-peak power. This equipment used is similar to that used previously for similar control of street lights. Standard carrier controllers are used for this purpose.

[23]Electrical Engineering, January, p. 114.
[24]Electrical Engineering, Oct., p. 1371.
[25]Electrical Engineering, June, p. 860.

German Experiments with Coal-Dust Engines*

ASIDE FROM ATTEMPTS to cut down imports of motor fuels by experiments with wood-gas generators for automotive vehicles, considerable attention is being paid in Germany to the development of a coal dust power machine.

The I. G. Farbenindustrie (German Dye Trust) has been making thorough trials with a 450 hp. coal-dust Diesel engine, the largest of this type built to date. Results of these trials, which concerned the output, efficiency, compressed air requirements, etc., showed that the mechanical efficiency of the coal-dust motor could be increased to 75 percent, while the consumption of heat could be reduced to about 2,700 calories per kilowatt hour.

This leads German combustion engineers to the conclusion that the question of further improvement of the combustion and the mechanical process is secondary to the cardinal question of diminishing wear and tear. Although trials have shown that the wear in the case of coal-dust motors without means for preventing deterioration often was 10 to 200 times as large as in the case of Diesel oil engines, nevertheless this wear may be reduced to a bearable degree through the use of special materials and designs for the packing materials, through appropriate handling, and by proper lubrication, and cleaning with liquids or gases. In addition to this, however, the ash problem still remains to be solved and an economical ash-removing process must be developed. It is hoped in Germany that the systematic concentration of all the experiences made up to now will satisfactorily solve the problem of deterioration in coal-dust motors in the near future.

As far as the question of the economic possibilities of coal-dust motors is concerned, the results of the trials of the German Dye Trust lead German combustion engineers to the conclusion that the coal-dust motor now surpasses the Diesel oil engine. As far as the steam turbine is concerned, the competition of the coal-dust engine in base load plants is hopeless, while in peak load plants it is possible.

These engineers are of the opinion that the coal-dust engine has become a national problem, an important part in the measures to supply the entire German fuel needs out of domestic raw materials. Even if the coal-dust engine cannot as yet be placed on the market, its further development will no doubt be significant.

*From a report by Vice-Consul C. T. Zawadzki, Berlin, Germany. Released by the Machinery & Agricultural Imp. Div. of the Bureau of Foreign and Domestic Commerce.

Many Power Topics to Be D

Results of Scientific Research Are Given Prominent Part in the Program Prepared for the Annual Meeting to be Held in New York, Dec. 3-7

WITH THE presentation of the technical program of the American Society of Engineers' 1934 Annual Meeting taking up only three days, December 4, 5 and 6, the available hours will be crowded with simultaneous sessions for the discussion of what promises to be extremely interesting papers and reports. Prominently in evidence on the program in the power field are papers giving the results of research work on equipment design, performance under test and commercial conditions and reports of progress being made in research work which has not yet been completed.

Papers of particular interest to readers of Power Plant Engineering are to be presented at a number of different sessions. Bearing analysis and practice will be taken up in two sessions with three papers to be presented. Five papers reporting investigations on fans will be presented in one session while two sessions on heat transfer problems will be devoted to six papers on various industrial phases of the subject. In the industrial power session, the flow distribution in forced-circulation once-through steam generators, and the influence of bends or obstructions at the fan discharge outlet on the performance of centrifugal fans will be discussed. An entire session will be given over to presentation and discussion of four papers on vibration as encountered in the operation of power machinery. Fuels will be discussed in one session, and equal time given to fluid meters. In the oil and gas power session, two papers are scheduled, one dealing with motor ships and the other with the maintenance schedule in Diesel central stations. In the two sessions devoted to central stations' problems six papers will be presented dealing with high pressure steam and binary cycles, fluid meter nozzles, test performance of Hudson Avenues's steam generating units, ten years of stoker development at Hudson Avenue, coal charges for banking, lighting and burning out boiler units, and a report on the progress in power.

From among the papers made available in advance of the meeting, the following abstracts have been prepared of those most pertinent to this field of power plant engineering.

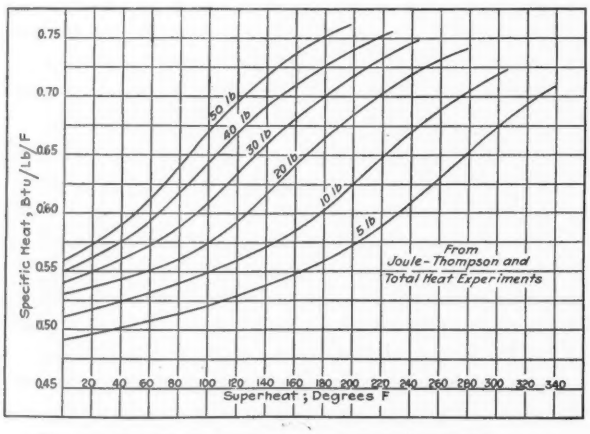


Fig. 1. Specific heat of superheated diphenyloxide vapor

High-Pressure-Steam and Binary Cycles as a Means of Improving Power-Station Efficiency

By Gustaf A. Gaffert, Worcester, Mass.

The possibility of employing two vapors in what is known as a binary cycle has held out potentialities for some time. However, it was only in July, 1923, that the first experimental plant of any importance was put into operation at Dutch Point, Conn., using mercury vapor and steam. This was followed by a commercial installation at Hartford, Conn. in 1930, and two larger installations in 1933.

A diligent search has been made for fluids other than mercury to use in a binary cycle, but the conditions that must be satisfied are so exacting that it has been possible to find only a few such fluids.

Briefly, a binary cycle is one in which one fluid is heated and vaporized in a boiler and expanded through a turbine, a certain amount of work being performed, with a corresponding reduction in heat content as well as temperature of the vapor. This vapor then flows into a condenser which is in reality a heat exchanger, for upon condensation it heats and vaporizes a second fluid. The first fluid after condensation is pumped back to its boiler, and completes one cycle, while the second fluid after vaporization usually has to be superheated before being piped to its turbine. After producing work in this second turbine, the second fluid vapor is condensed in an ordinary water-cooled condenser and pumped back to the original heat exchanger where it was vaporized, thus forming a second cycle.

Considering that available cooling-water temperature sets a minimum lower temperature of 50 deg. F. to 100 deg. F. depending on the season and that steam can be expanded efficiently down to this temperature, it is apparent that steam will probably remain the "lower" fluid in a binary cycle and other fluids will be used as the "top" fluid.

The following conditions must, in general, be satisfied by a fluid to be acceptable as a top fluid in a binary cycle:

Be Discussed at Annual A. S. M. E. Meeting

1. The vapor-pressure curve must be such that reasonable pressures, perhaps not over 300 lb. per sq. in., obtain at highest operating temperatures.
2. The critical temperature should be well above any possibly desirable upper limit of temperature for cycle operation.
3. The vapor pressure at a desirable condensation temperature should be nearly atmospheric or at least not so low as to require excessive power for maintenance of vacuum.
4. The specific heat of the liquid should be low, relative to water.
5. The fluid should not be costly and should be obtainable in reasonably large quantities.
6. The fluid should have no corrosive action upon metals ordinarily employed in power-generation practice.
7. The fluid should not be poisonous or toxic and therefore endanger human life.
8. The freezing point of the fluid should be well below ambient room temperature.
9. The fluid should be stable under conditions of cycle operation at elevated temperatures.
10. The vapor condition after expansion through a turbine should be nearly saturated so that a reasonable coefficient of heat transfer will obtain.

In the light of these requirements, several fluids have been considered. There are no known pure metals other than mercury which are not corrosive, have the required vapor-pressure relation, etc. Of the compounds there are diphenyl $(C_6H_5)_2$, diphenyl-oxide $(C_6H_5)_2O$ aluminum bromide, Al_2Br_6, and zinc ammonium chloride, $Zn(NH_3)_2Cl$.

Diphenyl and diphenyloxide are very similar in all physical properties, such as vapor-pressure curve, specific heat of liquid, latent heat, and specific heat of saturated vapor. Since experimental data were obtained upon a mixture of 75 per cent diphenyloxide and 25 per cent diphenyl and were taken as representative of diphenyloxide, complete data on diphenyloxide only will be developed. Diphenyl has the disadvantage of melting at 156 deg. F., so that there is danger of freezing the fluid in the pipe lines unless special precautions are taken to drain all the fluid back to the boiler when shutting down. Regarding cost, the Swann Chemical

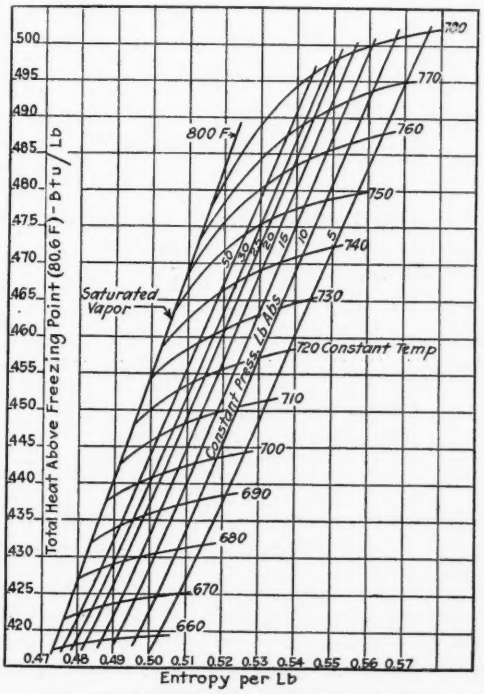


Fig. 2. Mollier chart for diphenyloxide

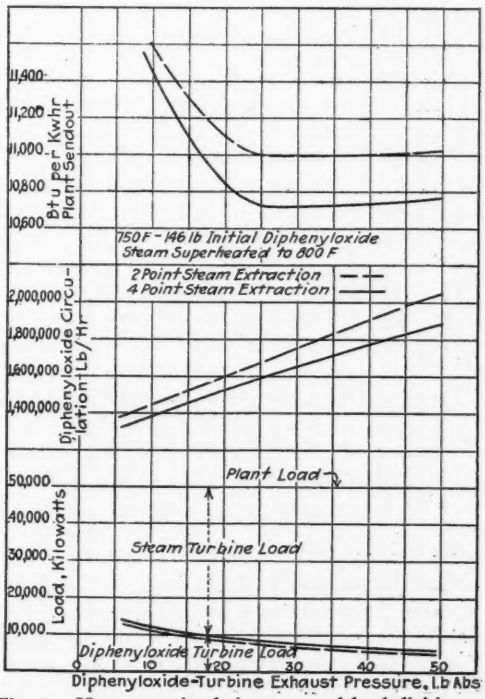

Btu per Kwhr Plant Sendout
750 F - 146 lb Initial Diphenyloxide Steam Superheated to 800 F
2 Point Steam Extraction
4 Point Steam Extraction
Diphenyloxide Circulation Lb/Hr
Plant Load
Steam Turbine Load
Load, Kilowatts
Diphenyloxide Turbine Load
Diphenyloxide-Turbine Exhaust Pressure, Lb Abs

Fig. 3. Heat rate, circulation rate and load division vs. diphenyloxide-turbine exhaust pressure

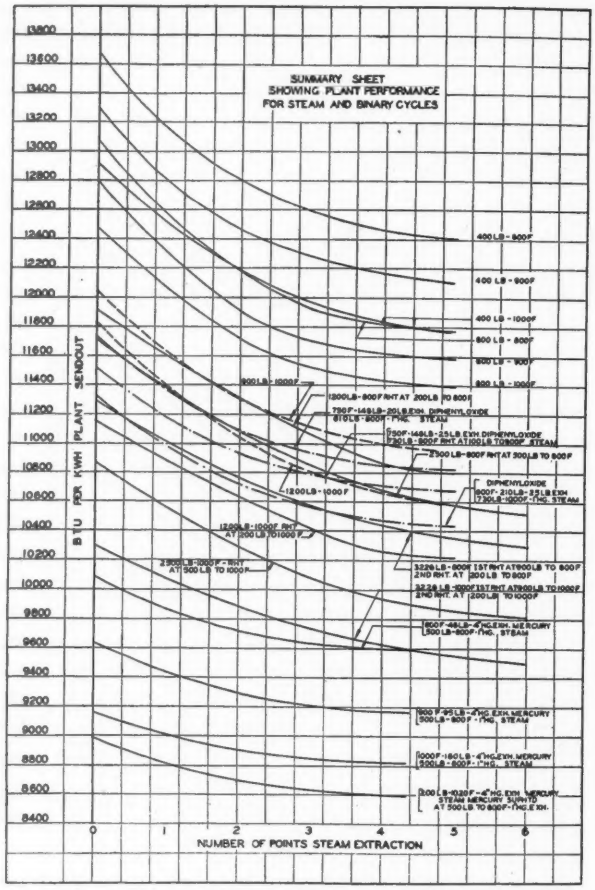

SUMMARY SHEET
SHOWING PLANT PERFORMANCE
FOR STEAM AND BINARY CYCLES
B T U PER KWH PLANT SENDOUT
NUMBER OF POINTS STEAM EXTRACTION
400 LB - 800 F
400 LB - 900 F
400 LB - 1000 F
800 LB - 800 F
800 LB - 900 F
800 LB - 1000 F
DIPHENYLOXIDE
800 F - 210 LB - 25 LB EXH
1130 LB - 1000 F - 1 HG STEAM
3226 LB - 900 F 1ST RHT AT 900 LB TO 800 F
2ND RHT. AT 200 LB TO 800 F
3226 LB - 1000 F 1ST RHT AT 900 LB TO 1000 F
2ND RHT. AT 200 LB TO 1000 F
800 F - 46 LB - 4" HG EXH. MERCURY
500 LB - 800 F - 1 HG. STEAM
900 F - 95 LB - 4" HG EXH. MERCURY
500 LB - 800 F - 1 HG. STEAM
1000 F - 160 LB - 4" HG EXH. MERCURY
500 LB - 800 F - 1 HG. STEAM
1000 LB - 1020 F - 4" HG EXH. MERCURY
STEAM MERCURY SUPPLIED
AT 500 LB TO 800 F - 1 HG EXH.

Fig. 4. Summary of plant performance for steam and binary cycles

Co., of Birmingham, Ala., stands ready to furnish this fluid in car load lots at 18 cents per lb. f.o.b. factory. Since the source of diphenyl is benzene there is no question of an ample supply of the fluid. It has no known corrosive action upon metals used in heat transfer work and is not poisonous. To summarize, since its other physical properties are similar to those of diphenyloxide, but its latent heat is slightly higher, it is confidently expected that its cycle efficiency will be only a per cent or so higher than a diphenyloxide cycle.

The zinc-ammonium-chloride cycle was established by Dr. E. Koeneman of Berlin, Germany, in 1930, and it will be discussed later in this paper. A short reference to the aluminum bromide-steam cycle is also given under a discussion of the various cycles.

At this point in the paper the author presents a detailed analysis of the possibilities of the high-pressure-steam cycles, the mercury-steam binary cycles and the diphenyloxide-steam binary cycles with Mollier and specific heat charts for diphenyloxide which the author had developed, then continues with a discussion of the various cycles.

Consider, first, the various steam cycles shown in Fig. 4. The improvement in thermal efficiency as pressure is increased is apparent and it can be seen from the shape of the curves that four to six extraction heaters represent the economic limit, the exact number depending upon fuel cost and fixed charges. The literature has demonstrated the justification of each pressure including the 1200-lb. reheat cycle. Regarding the higher-pressure plants for the 2500-lb. and 3200-lb. cycles, if the following operating conditions be assumed, we can make an economic analysis: Station capacity, 50,000 kw.; station average load factor, 70 per cent; hours annual operation (base load station), 8000; heating value of coal, 13,000 B.t.u. per lb.

In short, if the higher pressure is to be justified economically when compared to a 400-lb. 800 deg. F. plant, the added capital investment required must not exceed the figures shown in Table I.

Table I. 2500-lb. and 3226-lb. Cycles vs. 400-lb. Cycle

(4-point steam extraction)

	2500-lb. 800 deg. F Cycle	3226-lb. 800 deg. F Cycle
Heat rate, 400 lb. 800 deg. F. plant	12,460*	12,460
Heat rate higher pressure cycle	10,680	10,440
Heat rate saving	1,780	2,020
Coal saved per annum (tons)	19,100	21,680
Value of coal at $2 per ton (dollars)	38,200	43,360
Coal saving capitalized at 12.5% (dollars)	305,600	346,800
Capitalized saving per kw. at $2 per ton coal (dollars)	6.12	6.90
Capitalized saving per kw. at $3 per ton coal (dollars)	12.2	13.8

*See Fig. 4

It has been stated recently that a Benson generator would not cost any more than an ordinary type of boiler and, being an outside boiler, the boiler housing structure would be eliminated. The relative cost of the high-pressure steam and feed piping, high-pressure turbine and boiler-feed pump will, of course, determine the other added capital costs.

Aluminum-Bromide Binary Cycle

The few known physical properties of aluminum bromide (Al_2Br_6) taken from Mellor and an article by H. Barjot in Le Genie Civil are given in Table II.

Table II. Physical Properties of Aluminum Bromide

Melting point	90 deg. C. (194 deg. F.)
Boiling point (Atm. press.)	267 deg. C. (513 deg. F.)
Critical temp.	722 deg. C. (1330 deg. F.)
Specific heat solid	(22 deg. C.—76 deg. C.) 0.08912
Vapor density at 440 deg. C. (842 deg. F.)	18.64
Vapor-Pressure Data	
12 kg/cm²	500 deg. C. (171 lb. abs.—932 deg. F.)
1.2 kg/cm²	290 deg. C. (17.1 lb. abs.—554 deg. F.)
Heat of vaporization at atm. press.	21 kg. cal. (83.0 B.t.u.)

The only data on specific heat are those for the solid state. For a cycle analysis it was assumed that this value would be constant at 0.1 B.t.u./lb./deg. F. in the liquid state. The principal binary-cycle data for aluminum bromide are given in Table III.

Table III. Data on Aluminum-Bromide Binary Cycle

Vapor pressure at aluminum-bromide turbine throttle (lb. abs.)	170
Temperature of vapor to throttle (deg. F.)	932
Pressure at exhaust (lb. abs.)	15
Temperature at exhaust (deg. F.)	513
Temperature of steam from boiler condenser (deg. F.)	450
Pressure of steam at boiler condenser (lb.)	422
Steam quality at boiler condenser (per cent)	98
Steam temperature to turbine throttle (deg. F.)	1,000
Steam pressure to turbine throttle (lb.)	380
Steam pressure at exhaust (in. Hg. abs.)	1
Number of steam turbine bleed points	4
Final feedwater temperature from 4th heater (deg. F.)	350
Load on Al_2Br_6 turbine (kw.)	19,500
Load on steam turbine (kw.)	40,000
B.t.u. per kw-hr. to turbine	7,900
B.t.u. per kw-hr. plant sendout	9,660

When compared with other cycles shown in Fig. 4, the overall heat rate is promising. Aluminum bromide, however, combines chemically with water and forms hydro-bromic acid. The latter corrodes most metals

used in power generation practice and is dangerous to life, making it advisable to consider other fluids first.

Zinc-Ammonium-Chloride Binary Cycle

Dr. Koeneman's figures for this absorption-type cycle are given in Table IV. It consists of an upper cycle in which a zinc-ammonium-chloride solution is heated and one ammonia molecule is vaporized off the solution at an elevated temperature and expanded through a turbine. The ammonia-depleted solution is led from the boiler back through a heat exchanger to an absorber. Here it meets the ammonia exhausted from the turbine and union takes place with release of heat. Water is pumped through the absorber in tubes and vaporized. The vapor is then superheated and expanded through a second turbine, exhausted to a water-cooled condenser, and then pumped back to the absorber.

This cycle carries with it the decomposition of ammonia at high temperatures and probability of metal corrosion.

Table IV. Data on Zinc-Ammonium-Chloride Binary Cycle

Ammonia vapor pressure at turbine (lb. abs.)	99.6
Ammonia vapor temperature (deg. F.)	878
Pressure in exhaust absorber (lb. abs.)	2.28
Temperature of ammonia vapor in exhaust (deg. F.)	258
Turbine efficiency ratio (per cent)	83
Saturation temperature at concentration existing in absorber (deg. F.)	527
Vapor temperature of steam from absorber (deg. F.)	495
Vapor pressure of steam from absorber (lb. abs.)	650
Pressure at turbine throttle (lb. abs.)	611
Temperature to throttle after superheating (deg. F.)	842
Pressure in condenser (lb. abs.)	0.57
Turbine efficiency ratio (per cent)	83
Feedwater heating, 3 stages, final temperature (deg. F.)	329
Cycle efficiency, including auxiliary power for all purposes in both cycles but not including boiler (per cent)	41.7
Boiler efficiency, assumed (per cent)	85
Net cycle efficiency (= 35.4 per cent) B.t.u./kw-hr.	9630

Mercury-Steam Binary Cycle

This is one of the most promising cycles as seen from the location of the curves in Fig. 4. An economic comparison of a mercury-steam cycle with a 600-lb. steam plant, since the steam turbine operates at 500 lb. in the binary cycle, shows distinct advantages as shown in Table V.

Table V. 800 F., 46 lb. Mercury—800 F., 500 lb. Steam Cycle vs. 800 F., 600 lb. Steam Cycle

Heat rate 800 deg. F., 600-lb. steam cycle (B.t.u./kw-hr.)	11,810
Heat rate binary mercury cycle	9,600
Heat rate saving (B.t.u./kw-hr.)	2,210
Coal saved annually (tons)	23,800
Value of coal at $2 per ton (dollars)	47,600
Capitalized value of saving at 12.5 per cent (dollars)	381,000
Saving per kw. (dollars)	7.62

The mercury cycle involves, in the case of a 50,000-kw. plant, an investment of $4 per kw. in mercury thereby leaving a net saving of $4.62 per kw. or $181,000 per year for $2 coal. A similar comparison shows that the mercury cycle does not entirely outclass a critical-pressure steam plant when initial temperature is limited to 800 deg F. This binary cycle becomes more advantageous as the price of fuel increases.

Diphenyloxide-Steam Binary Cycles

As shown in Fig. 4, from a thermal standpoint, the cycle is on a par with the highest pressure steam cycles. The cycle wherein 800 deg. F. initial vapor temperature is suggested is a maximum because of decomposition over a period of time. There is also the problem of condensation of considerable superheat in the diphenyl-oxide-turbine exhaust abnormally large condensing surface may be necessary and, while the high molecular density gives a high mass velocity, experimental determination of overall heat-transfer coefficients are necessary.

An economic analysis comparing a diphenyloxide-steam binary cycle with a mercury-steam cycle shows that, when mercury and diphenyloxide-vapor temperatures are limited to 800 deg. F. and the steam is superheated to 1000 deg. F., there is practically an economic balance with $2 per ton coal. With higher temperature and higher fuel costs the advantage is wholly with the mercury-steam cycle. Also when metals become available for still higher temperature work, the mercury-steam cycle appears at present to be the only one which can take advantage of such an increase.

Conclusion

1. High-pressure steam plants show a decided thermal advantage even when auxiliary power is considered, and there is considerable margin available for increased capital costs. Analysis indicates that higher pressures are economically justifiable and that the steam cycle has not yet reached its limit.

2. When metals become available at a reasonable cost which will withstand 1000 deg. F. continuously, the mercury-steam binary cycle will show considerable overall economic advantages in its favor, and at higher temperatures it is the only feasible cycle.

3. Due to the small annual rate of production of mercury, both in this country and abroad, and its average market price, there is slight possibility that the mercury-steam cycle will become universal.

4. There is a best back pressure for the "top" fluid turbine for binary-cycle operation independent of turbine-efficiency ratios and number of bleed points on the steam turbine for feedwater heating, and dependent only upon the characteristics of such "top" fluid. In the case of mercury this occurs at 4 in. Hg. abs., while in the case of diphenyl-oxide it occurs at 25 lb. abs.

5. No thermal advantage is obtained by bleeding the mercury or diphenyl-oxide turbines in a binary cycle for the purpose of preheating the boiler-feed liquid.

6. When thermal advantages and capital costs, with particular reference to fluid costs, are considered in binary cycles, there is little choice between mercury-steam, diphenyloxide-steam, and high-pressure-steam cycles assuming low fuel cost and 800 deg. F. initial temperature.

Influence of Bends or Obstructions at the Fan Discharge Outlet on the Performance of Centrifugal Fans

By L. S. Marks, J. H. Raub, and H. R. Pratt
Cambridge, Mass.

The form and dimensions of the inlet ducts and inlet boxes of a centrifugal fan have been shown to have a profound effect upon the fan performance. The object of the investigations, described in this paper, was to determine whether bends or obstructions close to the discharge end of the fan have any similar influence. No such influence was found.

It may be concluded from this investigation that the operation of the fan tested was not affected to any appreciable extent by sudden enlargement or change of direction of the air stream as it left the fan housing. It is the opinion of the authors that the conclusions stated may be applied quite generally whenever the fan housing is sufficiently complete to give the discharged air a general direction of flow and a uniform distribution at the outlet. Any extension of the conclusion, however, to other types of fan and other arrangements of housing must be based largely on opinion.

The Relative Grindability of Coal

By Harold J. Sloan and Arthur C. Barnhart, Pittsburgh, Pa.

This paper points out the need for a standard method of determining the relative grinding characteristics of various coals. Several methods have been

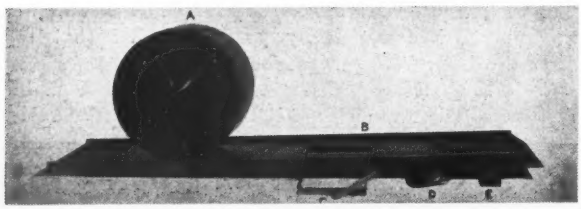


Fig. 5. Test roll and plate
A, Steel cylinder (8.5 in. diam. by 7 in. long); B, Steel plate (30 in. long by 10 in. wide); C, Hollow mold and spreading bar; D, Camel's hair brush; E, Tilting block in keyway

advanced and the authors herein are proposing another which they believe simpler to operate, duplicate, and control. A simplified roll test, designated as the C.I.T. (Carnegie Institute of Technology) roll test, is introduced, which is based on the principle of increase of new surface measured in accordance with Rittinger's theory of crushing.

Twenty-nine representative bituminous-coal samples were tested and their relative grindabilities determined by this method. Many of these values have been correlated with those obtained by the Fuels Research Laboratory (Canada) Method, the Hardgrove Method, and the Cross Method. An important phase of this paper is the discussion of particle-size determination by the sedimentation-velocity method. Particle-size distribution of minus-300-mesh coal has been studied experimentally and a more rational value for this size is proposed than has been done heretofore.

Coal pulverizers will have varying capacities with different coals and it is necessary that some standard test be established in order that a coal grindability may be determined and from this, the pulverizer capacity estimated. It is necessary that some coal be established as a standard and all grindabilities of various coals be relative to this.

A test for relative grindability must meet certain requirements, most important of which are:

1. Simplicity of construction and operation so that the apparatus may be obtained in a standard form at small expense.
2. The results of the test must be duplicable in the same laboratory and in different laboratories if the test is to be standardized for widespread use.
3. The relative grindabilities obtained with the test should be definitely related to actual capacities obtained with commercial pulverizers.

The results of pebble-mill tests indicated the desirability of obtaining a test with a closer control over the different variables such as distribution of feed, elements of grinding, etc., coupled with simplicity of construction and ease of operation. The idea was conceived that if a given weight of material to be tested was spread evenly over a constant area and a cylinder rolled over it a definite number of times, a test for the relative grindability of the various samples should result.

In order to test the possibility of the idea an area of 15 sq. in. was marked off on an ordinary steel bucking board. A steel cylinder 4 in. in diameter and 23 in. long was rolled five times over a 10-gram. sample of minus 20— plus 30-mesh coal, which was spread evenly over the marked area. Several tests showed enough consistency in degradation to warrant further investigation along this line, but it was thought that a heavier roll would give a more accurate balance. Accordingly, a solid machined steel cylinder 8.5 in. in diameter, 7-in. long, and weighing 105 lb. was obtained. This was a size of cylinder most readily available and is shown in Fig. 5.

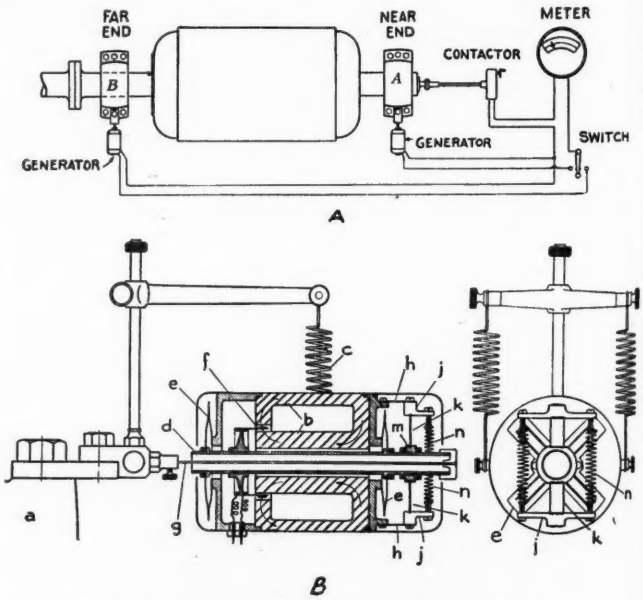


Fig. 6. Portable dynamic balancer connections and details of generator.

In the latter part of the work, they were able to correlate the grindability indexes obtained by the C.I.T. method with those obtained by the F.R.L. method, the Hardgrove method, and the Cross method by tests run on 15 standard samples of British Columbia coals, furnished through the courtesy of R. E. Gilmore, Superintendent Fuels Research Laboratories, Department of Mines, Ottawa, Canada. The grindability indexes are made relative to Hardgrove's standard 100-grindability coal, and in this way they were able to compare the results with his on eight of the 15 samples.

In five of the eight cases tested by both methods there is very close agreement between the Hardgrove grindability index and the C.I.T. grindability index. The samples as received consisted of two one-quart jars of minus 10-mesh coal. The procedure followed was to riffle the original sample down to about 250 g. and screen out the minus 20— plus 30-mesh component, discarding all the minus 30-mesh coal and the plus 20-mesh coal. Since the samples were prepared by alternate crushing and screening, it is believed that this 20 to 30 component is representative of the sample, but it would have been desirable to run tests on the minus 10— plus 20 mesh component to see if the relative grindability of this component was the same as that of the minus 20— plus 30-mesh size. The agreement with the F.R.L. method and the Cross method was not very consistent.

Dynamic Balancing of Rotating Machinery in the Field

By E. L. Thearle, Schenectady, N. Y.

In recent years both the users and manufacturers of rotative apparatus have given increasing attention to the matter of vibration elimination. This has resulted in considerable progress in the development of machines and processes for the production balancing of rotating parts in the factory. There exists also the problem of balancing rotating machinery in the field, with the rotor mounted in its own bearings and probably running under normal operating conditions.

Machines which have been serviced must often be rebalanced before use. Also, the state of unbalance of a rotor may change, as time goes on, due to the slight shifting of its parts or to the gradual relief of stresses in the shaft or body of the rotor. In such cases, which occur frequently, the cost and delay of disassembly, shipment of the rotor to and from a balancing machine, and reassembly are usually prohibitive.

Many rotors change shape slightly with changes of running speed, and will therefore show considerable unbalance at some lower speed in a balancing machine.

There have recently been built several very large turbo-alternators, the alternator field alone weighing over 100 tons, which is too great a weight for any available balancing machine. Such rotors must be balanced in their own bearings.

Thus there is a real need for a direct and scientific method of dynamic balancing in the field—one simple of application and utilizing readily portable equipment. The system of balancing to be described was developed in view of this need. Experience with this system indicates that in many cases its use accomplishes a better balance in a shorter time than is realized with the usual balancing machine.

Here the paper presents a discussion of that component of vibration which occurs at running speed frequency caused by mass unbalance in the rotating member and describes the method and means of measuring vibration and locating the position of corrective weights. This entire equipment, which employs some principles similar to the seismograph, may be packed in a portable case. Figure 6 shows the connections and diagram of the instrument.

Industrial Power Plant Efficiency

By S. H. Coleman

As AN INDEX of industrial power plant performance, the value of determining the overall thermal efficiency is often overlooked by the engineer in charge of operation. In all too many cases combustion efficiency is the only factor given consideration, with the result that the overall thermal performance of the plant is neglected and often times impaired.

Modern industrial power plants are usually justified because they can economically obtain a high thermal efficiency. In their design every effort should be exercised to obtain this efficiency by incorporating in the heat balance a high degree of flexibility to meet the inherent variables of the industrial load. It is by the manipulation and amplification of these provisions for flexibility that the operating engineer can often substantially improve performance.

The variables in industrial power plant load demands are accentuated by the unbalance found, in practically all cases, between the demand for process and heating steam and the demand for electricity. This unbalanced condition, subject, as it is, to so many variations requires continual checking if station heat balance is to be maintained at the point of greatest economy. Computation of the overall thermal efficiency of the power plant utilized in conjunction with combustion efficiency based on the same time intervals is invaluable to the engineer in this respect.

The determination of the thermal performance of the industrial power plant is relatively simple where measurements of station input and output are available. The formula for this determination will vary with each installation, but will have the general form:

$$E = \frac{H_p + (\text{Net K.W. output} \times 3415) - H_r - H_m}{H_f}$$

in which

E = Thermal efficiency expressed as a decimal.
H_p = Total heat supplied to factory process or heating service.
H_f = Total heat input supplied by the fuel.
H_r = Total heat returned from the factory to the station.
H_m = Total heat supplied in the raw water makeup.

Among the factors, other than combustion efficiency, tending to lower overall thermal efficiency of the industrial power plant and over which the engineer has a degree of control are:

1. Unusual variations in steam and electrical demands requiring correction outside the power plant.
2. Uneconomical scheduling of peak demands caused by intermittent operations within and without the power plant.
3. Uneconomical loading of boilers.
4. Uneconomical loading of prime movers.
5. Improper balance between electrical and steam driven auxiliaries.
6. Poor exhaust or bleeder pressure control resulting in excessive condenser or atmospheric losses.

By intelligent analysis of these and other factors influencing overall efficiency the engineer can usually discover ways and means of effecting large savings in the fuel bill.

Power Show *to Stress* Cost Cutting Equipment

INDICATIONS are that the predominating feature of the Eleventh National Exposition of Power and Mechanical Engineering to be held in the Grand Central Palace in New York City, December 3 to 8, will be the new power cost saving equipment exhibited to aid engineers in the solution of their plant modernization problems.

Air conditioning and refrigerating equipment will be augmented by a complete display of industrial fans and blowers, including centrifugal type turbo compressors and gas boosters. There will also be many devices for the vacuum cleaning of industrial equipment.

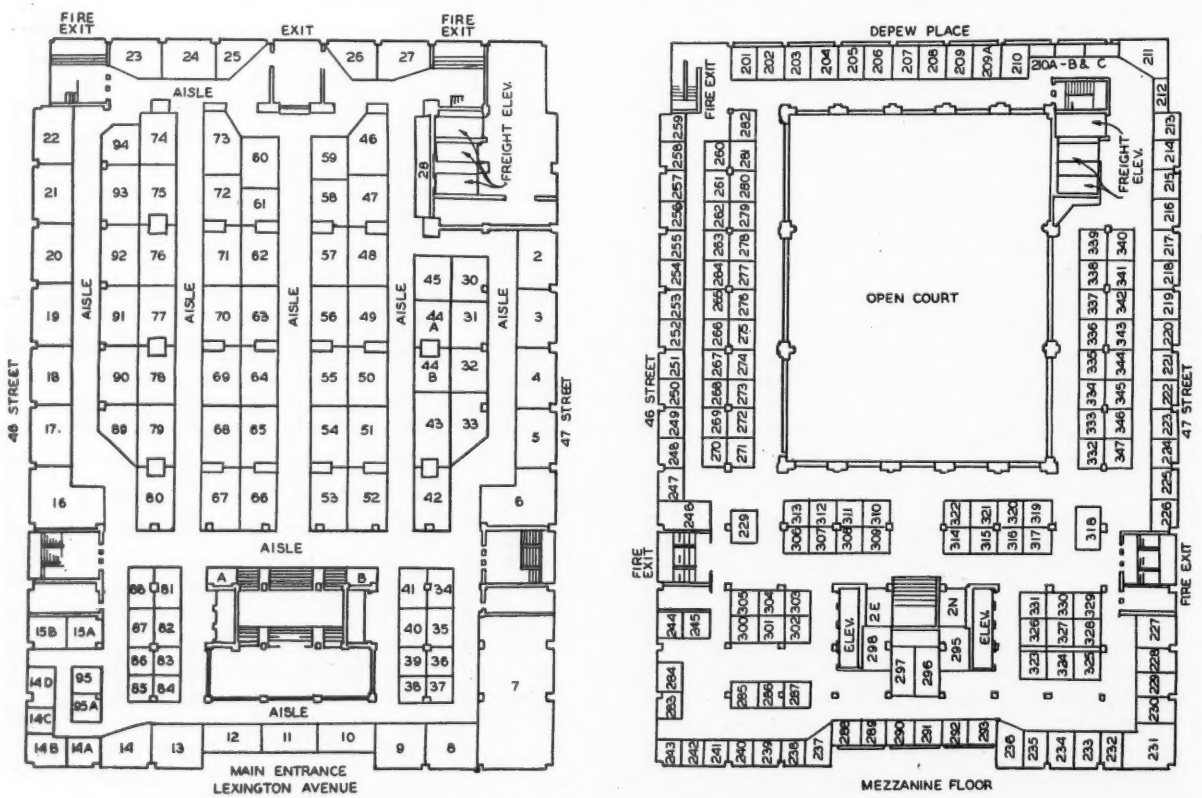
The refractory and insulation section will include fireclays of many types, chrome refractories, light weight refractories, special clays, high temperature bonding mortars, acid proof brick, and insulating brick.

Reduction of power and maintenance costs will be shown by an exhibit of electrical insulation. Instruments in this field include those to detect and diagnose faults in electrical equipment in order to forestall failure and shut-down. Related devices include ground testers for protecting equipment and human life from the danger of poorly grounded machine frames.

Steel and the various alloys will be the theme of some of the most interesting operating exhibits. The method of production of intricate castings will be illustrated in conjunction with an exhibit of high strength alloys and carbon steel castings, also castings of stainless and heat-resisting alloys.

Conduits which protect and insulate underground steam heating lines, superheated steam power, hot water, also brine lines, emphasize the savings which are made possible by a completely engineered, ready-made, conduit system. Tile and cast iron are the conduit materials. Inter-pipe insulation is waterproof asbestos. Alinement guides, pipe rollers, and other conduit accessories can be examined in the same exhibit.

Power generation equipment, boilers, heat interchangers, and the transmission exhibits will be supplemented by sections devoted to instruments, specialties



Plan of exhibit space at National Exposition of Power and Mechanical Engineering

and accessories which effect so many incidental savings in the power plants of the nation. There will be short flame burners, acid-sludge burners, also gas and oil burners for refinery stills. This feature will be auxiliary to the line of power and heating boilers.

Industrial filters will include types for practically every plant purpose. Heavy duty motor driven cleaning filters will be featured, also power plant filters for handling lubricating and fuel oils. Coupled with a display of firebrick and refractory materials will be the latest durable economical furnace observation ports and boiler gage glasses.

The materials handling section will include multiple lift trucks and ball bearing portable elevators. The economy theory of these devices will be to eliminate unnecessary piling and unpiling, loading and unloading—effecting corresponding savings in time, labor, and money.

List of Exhibitors Eleventh Exposition of Power & Mechanical Engineering

Exhibitors	Booth Numbers
Advance Engineering Company	271-275
Alexander Bros., Inc	291
Allen Billmyre Corporation	242-243
Allpax Company, Inc., The	253
American Brass Company	65
American Car & Foundry Co	201
American Chain Company, Inc	336-339
American Gas Association	7
American Meter Company	38-39
American Pulley Co., The	216
American Sand-Banum Co., Inc.	210A
American Schaeffer & Budenberg Div.	60
American Society of Mechanical Engineers	80
Appleton Electric Company	223
Armstrong Machine Works	271-272
Armstrong Steam Trap Co.	271-272
Atlantic Gear Works, Inc	334
Badger & Sons Co., E. B.	14D
Bailey Meter Company	54-55
Baldwin-Duckworth Chain Corp	247
Barco Manufacturing Company	302
Barrett-Cravens Company	74
Bernitz Furnace Appliance Co	78
Biddle Company, James G.	343
Bilgram Gear & Machine Works, The	308
Bird-Archer Co., The	36
Black & Decker Mfg. Co., The	279
Bond Company, Charles	213
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Boston Gear Works, Inc	326-331
Botfield Refractories Co.	94
Bradley Washfountain Co.	232
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Bristol Company, The	12
Brooklyn Union Gas Co	7
Brown Instrument Company, The	48
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Carey Company, The Philip	215
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Coe Mfg. Co., The	254
Combustion Publishing Co., Inc.	95A
Consolidated Ashcroft Hancock Co., Inc.	60
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How Coal *is Converted into* Electricity

FOR THE INFORMATION of visitors to Cahokia Station a large cross section of the plant was prepared to show the various steps in the conversion of coal to electricity. This drawing, reproduced here, was explained by C. H. Rules in the Union Electric Magazine.

A power plant is a large laboratory in which the energy available in coal, the principal raw material, is converted to electricity. The only other raw material entering directly into the process of conversion is air, which supplies the oxygen necessary to burn the coal. Water is used in large quantities, but is not consumed. It merely acts as a carrier of the heat.

The plant is divided into the following parts: Coal preparation, which includes unloading, handling, drying and grinding coal; boiler room, where coal is burned in furnaces, giving up heat which is absorbed in boilers and conveyed through pipes in the form of steam; turbine room, where heat in the steam is converted into mechanical power in turbines, the mechanical power produced in the turbines being converted into electrical power by generators to which the turbines are connected; electrical bay, where electric power produced in generators is diverted into proper channels for distribution to customers; river bay, which includes intakes for admitting water necessary for condensers under turbines, and water for boilers, which is clarified in a treating plant also located in this bay.

Coal Preparation

Coal is received in cars which are unloaded by turning them over in the car dumper. After being crushed and cleaned by screening and passing over electromagnets to remove foreign material which would damage equipment farther along, it is elevated to raw coal bunkers.

From the raw coal bunkers the coal flows downward through coal dryers for removal of moisture, to coal mills where it is ground to the proper fineness for burning. The pulverized coal passes into the blow tanks from which it is conveyed by compressed air to pulverized coal bins located in the upper part of the boiler room.

In the boiler room the pulverized coal mixed with the proper amount of air is burned in furnaces. The burning of coal produces hot flue gas, at about 2600 deg. F., and ash. The ash is conveyed out of the plant in the ash sluice located under the furnaces. The flue gas is cooled to 550 deg. F. by the boilers and additional heat is extracted from part of the gases to dry coal in the coal dryers. Part of the air required for

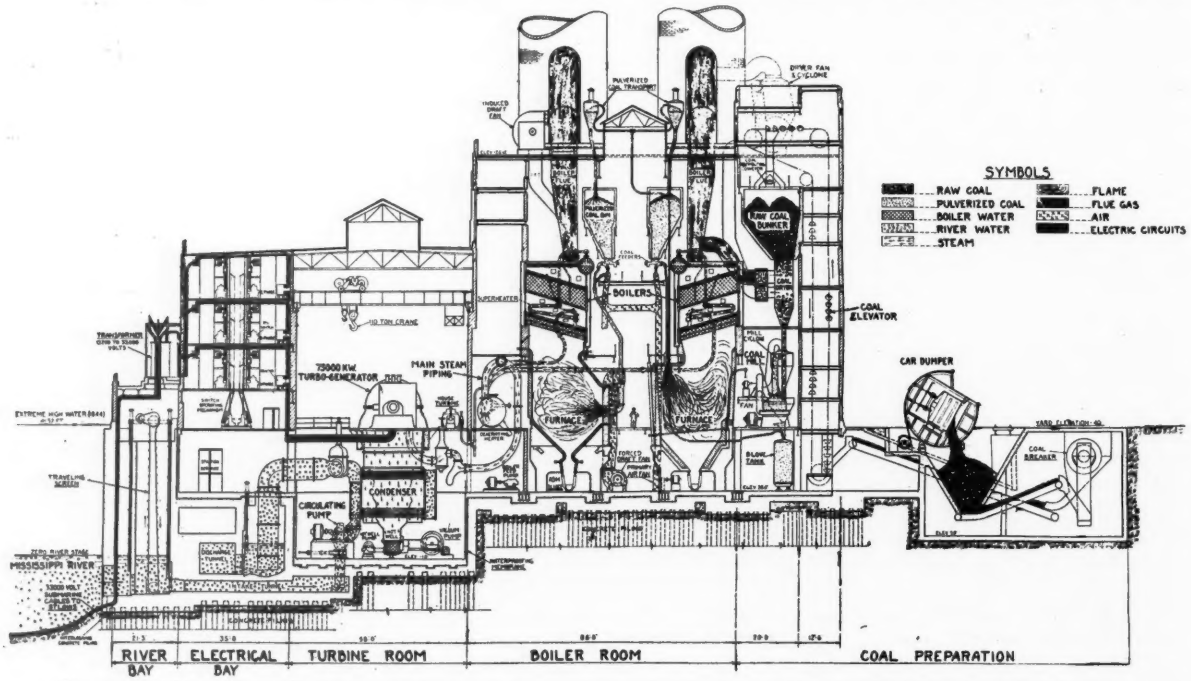


Fig. 1. Cahokia station split up into sections and drawn so as to show the various steps involved in making electric power

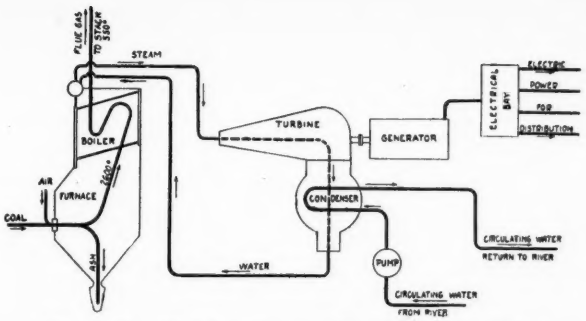


Fig. 2. Simplified flow diagram of a typical steam station

burning the coal is also preheated by the 550 deg. gas discharged from the boilers. All of the flue gas is finally discharged through the stacks, 345 ft. high, located on the roof of the plant.

Steam produced in the boilers is conveyed in the main steam piping to the turbine room. After passing through the turbine, this steam is exhausted into a condenser. The condensed steam drains to the hotwell under the condenser and is pumped back to the boilers through several heaters along the way which heat the water before it is again fed into boilers.

This forms a continuous circuit in which the water is converted into steam in the boilers, heat is taken from the steam in the turbines and converted into mechanical work, the steam is exhausted into the condensers and condensed into water which is again pumped into the boilers, the same water passing continuously around the circuit, with a small amount of make-up added to take care of leakage.

The generator shaft is coupled directly onto the turbine shaft, and the power developed in the turbine is used to rotate the generator shaft, which electric power generated passes to the electrical bay. The electrical bay contains the switching equipment and conductors required for transmission line distribution to substations in various parts of the territory served. Protective control equipment for automatically operating switches is also included in the electrical bay.

River Bay

Fronting along the river, the river bay is conveniently located for admitting circulating water to intake tunnels which supply the circulating pumps. After passing through the condensers the circulating water is returned to the river by way of the discharge tunnel. Water for boiler feed make-up is drawn from the circulating water supply and clarified in a chemical treating plant located in the river bay. Before being fed into boilers this water is evaporated for further purification.

For simplicity, a flow diagram, Fig. 2, is included. This is typical of steam power plants in general, and shows the various steps involved in the production of electric power.

Sterling Laundry of Indianapolis, by substituting a 339-hp., stoker-fired Stirling boiler for its two 100-hp. return tubular stokered boilers, increased efficiency from 57 per cent to 71.1 per cent and showed a saving of $1125 a year.

Setting Heights and Air Pollution

By William Culbert,
Chief Smoke Inspector, Nashville, Tenn.

TWO IMPORTANT issues are always with us in smoke abatement work; setting heights of small stoker-fired boilers, and elimination of fly ash, solids, and objectionable gases from stacks.

Despite a great deal of very earnest discussion, it still seems quite impossible for any group or committee to set up a standard of specific, iron-clad setting heights that are suitable for all sections of the country. There are many reasons for this, the main one being the different types of coal throughout the country. Another one is the various load demands made on the boiler, dependent upon the severity of the winter in different sections, or in the case of power boilers, the load demand on the boiler.

It is the sensible policy of smoke abatement officials not to resort to hair splitting exactness in regard to setting heights, but to be governed by good engineering practice in specifying the setting height for each installation, dependent upon the requirements of that particular job. In Nashville, it has been the practice to use approximately the setting heights of the Mid-West Stoker Asso., or roughly, 1 cu. ft., of combustion space to each 3 lbs. of coal burned per hour, based on peak loads.

Perhaps a greater service could be done if a code of standard procedure for the installation of stokers under small boilers were formulated, incorporating such features as long water leg boilers especially constructed for stokers for all new installations, and under old boilers to reduce to a minimum the wear and tear on refractory linings, and the proper methods of supporting boilers on brick or concrete foundations where necessary.

Air conditioning and air pollution is constantly receiving more attention from the public. Since clean, dust-free air is one of the important requisites of air conditioning, it seems that oftentimes the cart is being placed before the horse in this matter. Would it not help to stop some of the air pollution at its source rather than its final destination? However, there is a drawback to this plan. Smoke abatement officials have met with a great deal of success in their work because elimination of smoke by proper equipment has meant money saved for plant owners. A tangible economic question is answered.

On the other hand, air washers on stacks would be regarded only as additional expense, with only intangible benefits to the plant owner. Regardless of this, all large plants should have air washers or dust removers that will operate at certain definite efficiencies set up by a smoke or air pollution code. For the small plants and homes, flue gas washers have not progressed to a point where they are economically practical, and perhaps it would be well to postpone any ordinance affecting these until such time as the development of such equipment warrants such an ordinance.—Smoke.

Readers' Conference

Combustion on Chain Grate Stokers

AFTER READING the article Combustion Conditions in Chain Grate Stokers in the October issue, pp. 482-483, I was puzzled to know what conclusions the reader was expected to draw on the basis of the data presented. The original paper appeared in May 25, June 8 and June 15 issues of Engineering of London and many facts not given in the abstract throw considerably more light on the subject.

There were really two distinct and entirely separate phases of investigation as disclosed by the original article: A study of the progress of combustion from feed gate to ash pit; a study of temperature differences between the stoker links and preheated air beneath at different combustion rates. The study of fuel bed conditions was made on a Babcock & Wilcox natural draft stoker while the temperature study was made on an Underfeed Co. Type A, forced draft stoker.

Since conditions were not the same, facts observed in one study cannot be correlated to the other. The authors of the paper failed to take this into consideration, however. Combustion conditions with cold air under natural draft are quite different than with preheated forced draft and the peculiar shape of the fuel bed as shown in Fig. 1 of the abstract would not exist

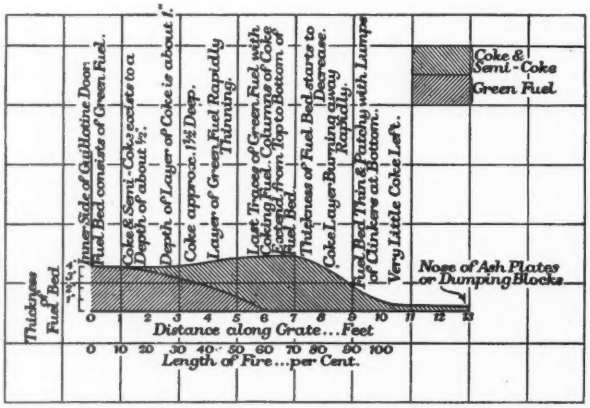

Coke & Semi-Coke
Green Fuel
Inner Side of Guillotine Door
Fuel Bed consists of Green Fuel.
Coke & Semi-Coke exists to a Depth of about ½".
Depth of Layer of Coke is about 1".
Coke approx. 1½" Deep.
Layer of Green Fuel Rapidly Thinning.
Last Traces of Green Fuel with Coking Fuel Columns of Coke Extend from Top to Bottom of Fuel Bed.
Thickness of Fuel Bed starts to Decrease.
Coke Layer Burning away Rapidly.
Fuel Bed Thin & Patchy with Lumps of Clinkers at Bottom.
Very Little Coke Left.
Nose of Ash Plates or Dumping Blocks
Thickness Fuel Bed
Distance along Grate...Feet
Length of Fire...per Cent.

Fig. 1. Section through the fuel bed as drawn from the original investigations

if forced draft were used, particularly if the stoker were properly zoned and the coal tempered.

Even with cold natural draft the fuel bed would not take the shape as shown if the coal had been properly tempered before passing beneath the feed-gate (English call it guillotine door). Uniform addition of about 3 per cent moisture will prevent excessive "cauliflowering" (see original article) and the fuel bed will not appreciably increase in thickness as shown in Fig. 1. Instead, it will assume the shape shown in Fig. 2 of this article.

There are several important advantages in properly tempering coal: better ignition; fewer holes in the fuel bed with decreased "cauliflowering;" less carbon in the ash pit; less siftings and less draft loss through the fuel bed for a given combustion rate or a higher combustion rate with a given draft. The original article showed the combustion rate varying from 10 to 30 lb. per sq. ft. per hr., but did not state at which rate conditions were obtained as shown in Fig. 1.

It is little wonder that such conditions existed in view of the odd scheme adopted by the authors to withdraw the fuel bed on a grid after combustion had progressed from feed gate to ash pit. It is stated that this grid had ½ in. square holes but the dead space between holes is not given and we do not know how much of the ½ in. openings coincided with the air spaces through the grate surface. Air follows the path of least resistance.

Even in the original article the furnace design for the natural draft stoker is not shown but the original Fig. 6, reproduced here as Fig. 3, shows why they had trouble with overheated and burned links. Although no dimensions are given, it may be assumed that the arch is at least 42 in. above the grate surface and by comparison the corbelling of the bridge wall just above the rear of the stoker is almost this same height. It is little wonder, therefore, that the links in the grate surface burn. Examination of most burned stoker links shows that this burning occurs on the lagging end as this end is tilted up when the links break open upon passing around the rear sprocket.

Investigation as to why this happens usually discloses a straight bridge wall or one with useless corbelling as shown in Fig. 3. In order to protect the ends of the links from the radiant heat of the bridge wall, after the protecting coat of ash has slid off, there should be a short rear arch or at least, a "water-back" built into the bridge wall. Construction embodying a "water-back" is shown in Fig. 4. This serves a double purpose. It not only protects the bare links from radiant heat but also serves to deflect forward the cold excess air which usually passes up

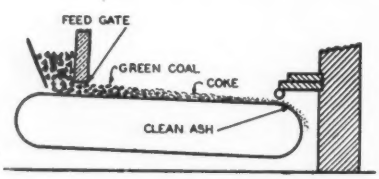


Fig. 2. Section through a fuel bed properly tempered, with good air distribution

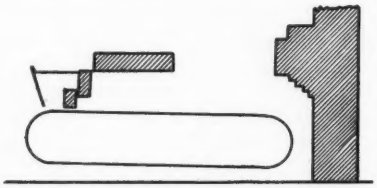


Fig. 3 Furnace construction showing why the stoker links burn off at the end

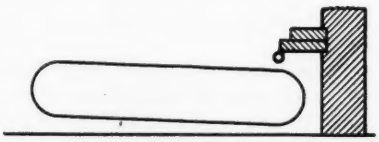


Fig. 4. Furnace construction which protects the rear end from radiant heat

along the bridge wall, so that it will mix with the combustible gases arising from the fuel bed.

I sincerely hope that none of our American operators are led into adopting such a method of protecting the links from overheating as disclosed by the British investigators. Two wrongs do not make a right as the scheme of increasing the ash content of the fuel might seem to indicate.

If grate surfaces are designed to allow for sufficient expansion due to use of preheated air no trouble will be experienced even if the air temperature should be 400 to 450 deg. F. Even higher temperatures might be used but ordinarily in boiler practice the comparatively low temperature of the gas entering the heater makes it uneconomical to heat the air over 400 deg. F.

The mere fact that the temperature is 350 or 400 deg. does not cause the trouble but radiant heat does. Sometimes the grate surface in the center of the stoker is exposed to direct radiant heat if a hole is burned in the fuel bed due to "cauliflowering" and then the protecting coat of ash gets blown off. But, as pointed out before, we can stop holes in the fuel bed by proper tempering and proper air distribution.

In conclusion, then let me say that irrespective of the combustion rate and the air temperature within the limits of economy, no serious trouble due to overheating of the links should be experienced if the coal is properly tempered, the air uniformly distributed and the rear end of the stoker adequately protected from radiant heat.

Glen Ellyn, Ill. J. R. DARNELL.

Care Saves Trouble

FIRE is a constant source of danger especially around plants where oil, grease and paint are employed. As power plants come in this class with all kinds of combustibles around, power plant employees should be doubly careful. Never leave piles of oily trash or waste around. It is a constant source of danger from spontaneous combustion and a good target for matches or coals knocked from pipes or cigarettes. Sometimes these piles will smoulder for hours before breaking into a blaze and at night a fire always has a better chance to get started. Greasy clothes in lockers also come in the same class. Soldering torches carelessly used can also start dangerous fires immediately or catch odd ends as it is carried around. Gasoline, kerosene and above all benzine are extremely dangerous to have around and should always be kept in tin cans, never in bottles.

Ladders are also a source of danger for the careless even though the people may not be superstitious. Rungs should be spaced uniformly and securely fastened. Before ascending see that the ladder is securely placed so that it cannot slip. Smooth finished concrete makes a dangerous footing especially if the ladder is tipped with iron shoes as some frugal individuals have been known to do in order to keep it from wearing. A piece of old auto casing can be used to much better advantage from both a utilitarian and safety standpoint.

Old nails are a fertile source of blood poisoning and should be eliminated either by driving all the way in or pulling out. The danger is always greatest during repairs because there is always a lot of boards and old lumber about and it is next to impossible to make the workmen realize the danger. Cuts or wounds from a nail are seldom dangerous in themselves, the chief danger lies in infection which often leads to blood poisoning. First aid and thorough disinfecting should be attended at once.

Springfield, O. F. PAUL.

The Operating Engineer

DISCIPLINE in an industrial company plant is inclined to be rather lax perhaps because the men are usually few, the organization simple and the men knowing each other well know what to expect from their associates. Some men are notoriously lazy and although they may do their work well will shift everything possible on to the man who relieves them while others will do everything possible so that the man just coming on has little or nothing to do unless an emergency of some kind comes up. In fact operating men should not have much to do in the way of regular duties except operate the machines and be wide-awake in an emergency.

At sea each man must have his particular job in good order before he leaves and the oncoming operators come on early enough to make a thorough inspection before they take things over. After the watch is taken over the responsibility is theirs but they do not have to do this until they are satisfied that everything is all right. If a hot bearing is discovered for instance and complaint made the former oiler takes care of it until it cools down. On land this is not possible or at least not practical but the engineer should come on early enough to receive a report of conditions from the retiring engineer and check up on some of the major points before the other engineer leaves. Above all he must be sure that he has sufficient men on hand to operate the plant before those scheduled to retire from duty are allowed to leave.

The report from the retiring engineer should cover the condition of the equipment, any unusual developments during the previous shift and any expected load changes. In an industrial plant the load can usually be foretold with considerable accuracy. The engineer should then check up personally on each item of equipment and look at the different charts and gages to be sure that they are operating, properly labeled and dated. The charts should all be changed by one man, in a small plant the watch engineer of the dullest watch should do this but in a large plant a regular instrument man should be provided for. The repair and inspection of instruments in an average plant is not a difficult job for one of average intelligence and mechanical ability but the work must be done regularly or soon all the instruments will be out of adjustment or stopped and the records will be useless. I have seen charts changed regularly on recording gages that had not been running for weeks.

In the boiler room the water column should be blown down and the gage glasses tested or checked by means of the gagecocks. Instruments should be checked and the fires inspected. Boilers should be carrying their share of the load. Checking the water level and inspecting the gage columns and fires will prob-

ably already be done by the boiler room operator just as each operating machine will be inspected by the individual operator as soon as he comes on watch and before taking the shift over. This, however, does not relieve the watch engineer of the responsibility of checking up personally.

The engineer should also be on hand and, preferably, do the work or actual handling whenever a machine is taken off the line or another one put on or when a boiler is taken off the line or put on. Reasonably attentive operators can be depended upon to do the right thing but if later on somebody is scalded by a leaky stop valve or an open blow off valve or half the turbine blades are taken out of the hotwell pump the responsibility lies with the engineer. The operator gets paid for twisting the valves and the engineer for seeing that he twists them right and at the proper time.

Brooklyn, N. Y. P. F. ROGERS.

Transformer Capacities in Small Hydro Plants

FUTURE ENGINEERING development is bound to include considerable small hydroelectric plant construction although at present little private work in this field is in progress. The relationship between generating capacity and transformer ratings in such plants is of interest even today, since system surveys often bring uneconomical and inflexible arrangements to light. There is something beyond equating transformer and generator ratings in adapting plants to efficient service. Transformer investment is "on the carpet" today along with many other plant items of equipment, and shifts of units may well be studied in relation to present and expected loads, as well as in connection with water conditions.

In one 2000-kv.a. hydro plant, for example, the two generators deliver energy at 2300 v. to a common bus. Two transformer banks rated at 1500 and 600 kv.a. respectively are fed from this bus through circuit breakers, and deliver 66-kv. energy to a high-tension bus split by a bus tie switch and feeding load centers east and west of the station. It is apparent that if one bank fails the other will be able to deliver less than the output of the combined generating units run at full rating if the larger bank remains, and only 60 per cent of the output of one unit if the smaller bank stays in. The combined bank rating exceeds the generator combined rating by only 5 per cent. If one generator fails or if the flow of water prohibits using two machines anywhere near full load, full output of one unit can be delivered only by the larger bank. At first blush it seems as though either transformer bank should have been large enough to carry one generating unit at full load, which would have specified three 333-kv-a. units for the smaller bank even if the larger one had been left at three 500's for flexibility's sake. The added cost would have been small in relation to the station total, and under suitable water conditions the combination might work out very well indeed.

Such situations, however, point to the importance of going into these relationships with thoroughness. The plant in question runs about 10 hr. a day the year through, even in drier seasons thanks to excellent storage. To ascertain the most economical size of transformers therefore involves a comprehensive study of unit loadings, transformer efficiencies, open-delta possibilities, generator usage, cost of outdoor structures associated with different sized banks, investment and overheads, relation to other sources of power on the system, and the losses accruing from partial use of plant and water at different times. Without knowing much more about the operating conditions, therefore, it would be out of place to pass judgment on the design as composed of ill-assorted transformer banks. The engineering moral of the case is simply the importance of analyzing various combinations of equipment carefully before building the station and where conditions warrant it, of periodically checking the economic adequacy of the installation components as a guide for future action and betterment of service.

Cambridge, Mass. H. S. KNOWLTON.

When I Build a Power Plant

WHEN THE upswing of business occurs there will be intense activity in the building of new, and the revamping of old, power plants.

Manufacturers are, at heart, individualists and they prefer to have their power equipment under their own control to the alternative of buying from the public utilities. Furthermore, it is very often good economy to combine the making of process steam and plant power.

A point that is often overlooked, however, is the operation and maintenance of a power plant after construction is completed. Far too often the design and construction is left entirely to technical men many of whom, clever as they are in their own sphere, have not had extensive practical operating experience. The writer has had experience in the construction and initial operation of several installations in various branches of industry and he has always come across the same condition. That is, that the coöperation, during construction, of a good operating engineer as distinct from a construction engineer would have amply repaid the owner over a period of years.

Equipment has to be overhauled and inspected; glands repacked; gaskets renewed; valves ground in; lagging taken off, all of which required time and material often wastefully used because the equipment was placed inaccessibly, or for some other reason which would be apparent at once to a man whose lifetime job had been the maintenance of such equipment and could easily have been corrected at the time of construction.

The practice of welding gaskets, welding valves on pipes is, in many cases, excellent but, quite often, a service of exasperation and expense to future operators. Every engineer knows that some gaskets need periodical replacement. Every engineer knows that some valves need frequent grinding. Yet, when the pipe coverers get through with their work, the lagging is usually a homogeneous job that has to be destroyed before any repair can be effected. It is impossible to replace the lagging in its original condition and, consequently, the replacement is done inefficiently or left off altogether with resultant heat loss. I be-

lieve that the last foot of pipe covering before the flange should be a separate hinged piece. The lagging over the valves should be removable also. Yet this extra expense never appeals to the Construction Department and the Owner pays for it many times over in after years. Another item is the installation of brass pipe for water service. The initial extra cost would be money well spent in many cases but, to many construction men, scale and rust are still mysteries.

These and other little items, small as they are individually, become a large liability over a period of time.

Too often the seller of equipment will bring his prospective customer into a recently constructed plant using this equipment. The prospect will, in most cases, look around and leave without a word to the men who could really help him in his decision. He will talk to the Chief who, for policy, will naturally give a rosy picture but will pass over the men who are, quite often, up to their eyes in work that could have been obviated.

The prospective purchaser of equipment, when building his power plant, should engage his chief engineer at the same time that he lets his construction contract.

Passaic, N. J. M. SECUNDO.

Equipment Needed for Electric Welding

Q. COULD YOU FURNISH ME with information in regard to electric welding apparatus we might use in our plant. We have a direct current system of 230 v., and would like to manipulate this current so we can do electric arc welding. We would like some idea of the equipment needed. The work is practically light work, sheet steel up to ¼ inch. C. W. F.

A. While alternating current is used for electric arc welding, direct current is most generally used. It would be inadvisable, however, for you to use your 230 v. direct current supply for arc welding without the use of a motor generator set which converts this relatively high voltage, to a voltage of the order of 25 to 60 v.

Most electric arc welding requires a voltage anywhere from 20 to 30 v. and to reduce your line voltage to this value would involve considerable losses in the resistors that would be necessary. Also since currents of from 20 to 150 or more amperes are necessary it is doubtful whether your system could withstand this drain without excessive drop in voltage.

The arcs used in electric welding are usually fed from a special low voltage direct current generator, delivering 60 or 70 volts and capable of supplying currents of from 20 to 100, 200 or 300 and 400 amperes. A number of manufacturers supply these sets in sizes from 2 kw. up.

Two processes are in use; the carbon electrode process and the metallic electrode process. The carbon electrode process is somewhat limited in its application and for general work, today, the metallic electrode process is more generally used.

In this process, a metal rod or pencil is made the negative terminal and the work to be welded becomes the positive terminal. When the arc is drawn, the metal rod melts at the end and is automatically deposited in a molten state in the hottest portion of the weld surface.

If the proper length of arc is maintained uniformly on clean work, the voltage across the arc will not usually exceed 22 v. for bare electrodes and 35 v. for coated electrodes. While the voltage normally required is from 20 to 30 or 35 volts, it is often necessary to overcome the resistance of partly cooled slag which forms at the weld requiring from 90 to 100 v. Such voltages may be obtained by using a 60 v. direct current supply with a reactance coil in series with the arc. Any sudden fall of current induces a sudden inductive voltage kick so that the total voltage is normally sufficient to overcome the increased resistance. However, if a welding outfit is purchased complete from the manufacturer it will be unnecessary to take this into consideration as such machines have incorporated in them all the necessary control equipment for maintaining the arc at proper voltage under varying conditions.

You state that the work which you wish to do will involve sheet steel up to ¼ inch. For this thickness of plate (mild steel) the customary electrode diameter is ⅛ inch and the amperage required, from 90 to 125. A machine of 200 amp. capacity would therefore meet your requirements nicely with plenty of allowance for overload.

Utilizing Waste Heat from Internal Combustion Engines

IN THE NOVEMBER ISSUE, page 517, we read, "That little has been done in improving the efficiency of the Diesel engine since the days of Dr. Diesel."

What is now called a Diesel engine would not be recognized as such for one basic change alone. Dr. Diesel's feature of using air injection is now obsolete. Sir James McKecknie introduced, developed and proved the superior value of solid injection at the Vickers Co. Ltd., where he was during the War. That is history and all recognize that value. As for reference to Sir James see Engineering (London) Oct. 23, 1931, pages 532-533. His history is interesting when we find he started at the age of 15 and did much to prove his ability as a great engineer.

Cleveland, Ohio JAMES MCINTOSH.

IMPROPER and inadequate industrial lighting is costing the nation about one and one-half billions of dollars a year in accidents, according to the National Safety Council. A similar deficiency in street illumination adds about $200,000,000 to that bill every year, which costs more per capita than the actual cost of the lighting itself.

The Council also declared that one-third of the nation's annual lighting bill could be saved by means of soap and water, light-colored walls, and proper reflectors, reports the New Jersey Public Utility Information Committee. In other words, light-colored walls kept clean would provide more efficient reflection, which, properly directed, would result in an annual saving of several hundred millions of dollars.

New Equipment

New Oil Refining

NOT CONTENT WITH older refining methods, the Socony-Vacuum Oil Co., working with a large staff of chemists and refinery engineers, has developed the Clearosol process for refining lubricating oil by washing with solvents to remove impurities such as tar, gum and sludge from the crude oil.

When tests of oil from a small pilot plant which produced about two barrels of the new Mobiloil a day were completed, it was decided to build two new refineries, for 2000 bbl. a day each, one at Paulsboro, N. J., the other at Beaumont, Texas, and today both are in successful operation.

High automobile road speeds approaching 90 miles per hour and engine speeds of 4000 r.p.m. have brought valve stem temperatures to 700 deg. F., while winter operation requires that oil preserve its fluidity at low temperatures, hence service expected from both engines and oils requires motor oils having characteristics unheard of a few years ago. It was felt that the most logical way to separate the impurities from oil was in a physical fashion, as you would separate sand from sugar with water, by pouring water on the mixture to dissolve out the sugar. This is the principle of the Clearosol process, eliminating the use of sulphuric acid and clay.

Solvents used in the new process act in two ways, one type by precipitating from the oil those substances which tend to form carbon in the engine, the other type by removing substances which are unstable at high temperatures and which change greatly in viscosity with changes in temperature. The amount and type of each solvent needed depends on the oil processed, the process giving control over the product, to get the highest quality obtainable.

Oil made this new way is said to last up to 25 per cent longer in bearings, to prevent stuck piston rings, gummed valves or similar motor troubles, to cut down carbon in internal combustion engines, yet at no added cost to the consuming public.

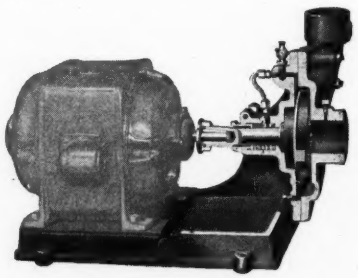
New High Temperature Soot Blower Element

AFTER LONG RESEARCH and experimentation, the Bayer Company of St. Louis, Mo., has, with the cooperation of metallurgists specializing in high temperature alloys, developed a soot blower element possessing the essential properties for long life in this severe service where temperatures above 2100 deg. F. are sustained.

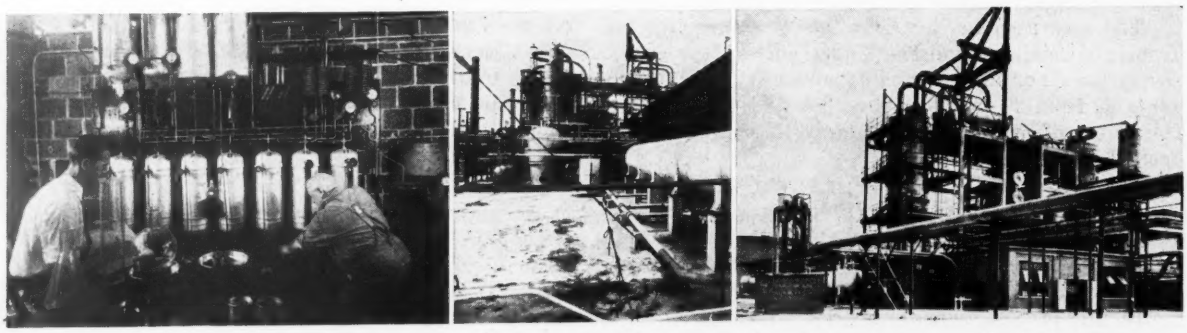
This alloy, known as Chronilloy, is an alloy of chromium and nickel with other elements added, making a total alloy content running from 40 to 80 per cent, to give it the required properties. The alloy is exceptionally tough and strong at elevated temperatures and Chronilloy soot blower elements do not become brittle and crack. The elements are made with an exceptionally heavy wall—20 per cent heavier than ordinary extra heavy alloy tubing—so that the elements resist warping. Many difficulties had to be overcome in perfecting the technique for fabricating this alloy into soot cleaner elements. Chronilloy elements are furnished in two grades depending upon service conditions. They are made in either 1½ or 2 in. sizes.

Close-Coupled Pumps

STANDARD - MOTORMOUNT UNITS. A new line of close-coupled, side suction centrifugal pumping units were recently announced by The Deming Co., Salem, O. Any make



of standard ball bearing motor of the open, enclosed, splash-proof or explosion-proof type can be used, as the connection of motor and pump shafts eliminate the necessity of special motor end bells and shafts. Pump and motor are mounted on a substantial base plate and the cradle mounting of the pump permits expansion when handling hot liquids without disturbing the alinement of the unit.

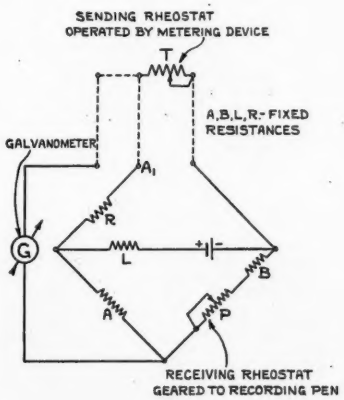


Pilot plant, new solvent recovery equipment and condenser and exchanger plant for the Clearosol process of Socony-Vacuum Oil Co. at Paulsboro, N. J.

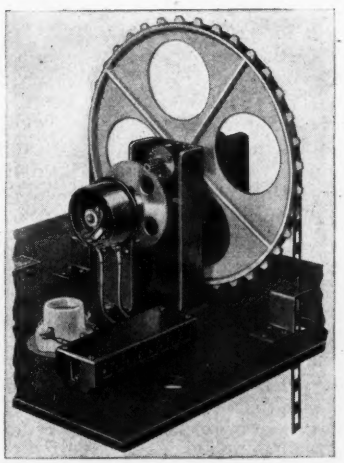
A New Telemetering System

A NEW TELEMETERING system has recently been developed and placed on the market by Bailey Meter Co. This system, which is applicable to the measuring of pressure, temperature, liquid level, etc., at distant points, incorporates an electronic relay in conjunction with a Bailey Galvatron receiving element. The transmitting element consists principally of a variable resistance unit which is operated by the metering device.

The accompanying diagram shows the circuit used. For distances up to 10 miles an accuracy



to within one per cent of the scale reading is claimed by the use of a three wire connection between the metering device and the remote recording apparatus. Telephone lines may be used as the connecting link between the transmitter and the receiver. A variable resistance, T, is adjusted in accordance with the flow or other factor to be metered.

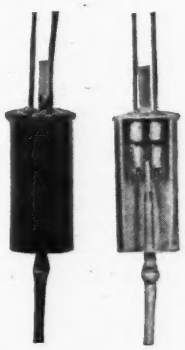


Resistance, P, of the receiving element automatically balances T so that a pen geared to P indicates the position of the metering device driving the variable resistance T.

Where distance is less than three miles, a two wire connection may be used. In this case the galvonometer is connected to the bridge at A_1. With this method an accuracy to within one per cent of the maximum scale reading can be obtained. Only a small amount of current is required for this system because a vacuum tube amplifies the transmitted power to a sufficient degree to secure positive operation of the equipment. Dry cells, which are used to provide the necessary direct current supply, should last from six months to one year. The receiving element is mounted in a neat appearing, moisture-proof, pressed steel case and records as many as four factors on one 12 in. circular chart.

All-Metal Vacuum Switch

A NEW SMALL vacuum switch, made almost entirely of steel and designed to take advantage of the absence of an arc when breaking a circuit in a high vacuum, has been announced by the General Electric Co. Although this new vacuum switch is only about ¾ in. in diameter and 1½ in. long, and can be operated by a fraction of an ounce of pressure, it is capable of interrupting as much as five horsepower



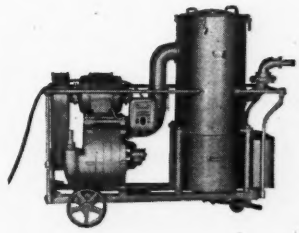
as fast as thirty times a second. Designated as the Type FA-6 vacuum switch, this new device is rated at 10 amp., 250 v. d.c. or 440 v. a.c.—or 5 amp. at 500 v. d.c.

The G-E Type FA-6 vacuum switch is made of steel, hydrogen-copper-brazed and exhausted to a high vacuum through a hollow steel operating stem. This operating stem passes into the vacuum contact chamber through a thin steel end-wall whose flexibility permits the slight motion necessary for operation of the contact. The leading-in wires to the contacts are sealed in tiny glass beads inside small Fernico alloy thimbles which are inserted through the heavier opposite end-wall of the chamber. The Fernico-glass seal is a development of the General Electric Research Laboratory, and provides a sturdy and reliable gas-tight joint.

With this construction, the Type FA-6 vacuum switch can be used in almost any location, including those subject to severe shock and vibration. Constructional details are clearly shown in the illustration.

New Invincible Vacuum Cleaner

INVINCIBLE VACUUM CLEANER MFG. Co., Dover, Ohio, has placed on the market the Industrial Master Truck Cleaner. A 5-hp. motor driving a 4-stage turbine exhauster through a Texrope drive produces a suction of 70 in. water-gage at a volume of 265 cu. ft. per min.

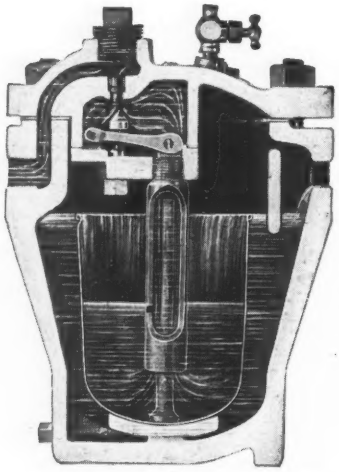


Separation of all foreign matter from the air before it passes through the fans is one of the important features of the cleaner. All dirt is collected in a container located under the separator close to the floor, facilitating the removal of collected dirt. Overall dimensions of the machine are: height, 57 in., width, 21 in., length, 67 in.

SULLIVAN MACHINERY Co. has placed on the market a casting grip, for holding medium size castings, 2 to 20 in., having one jaw whose position can be changed by hand, the other operated by air, to close slowly but release instantly. The casting is held firmly, grinding and chipping tools being brought to it for the snagging operations. Fast grinders can be used, as it makes no difference whether the casting becomes heated. Greater output and better work are thus made possible.

New Nason Traps

NASON MANUFACTURING CO., New York City, is now marketing an entirely new design of bucket steam trap under the trade names of Titan, in four sizes for pressures up to 300 lb., and Tiny, in two sizes for pressures up to 150 lb. A lever in the top of the trap enables placing the bearings in clean water protected from wear by scale and grit,



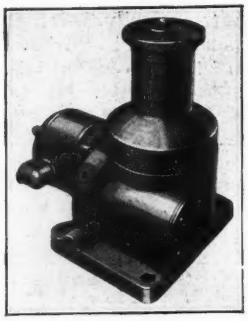
and gives to the trap compactness and capacity. The design eliminates troubles due to air binding, wire-drawing, pulsating pressure and grease floating on condensate.

Sudden and complete opening, and quick and tight closing of the valve are accomplished by the use of an open bucket as the source of power working through a lost motion mechanism. Adjustment for different pressures requires changing the valve seat only and the entire mechanism is removable without taking the trap out of the pipe line.

Link-Belt Motorized Car Spotter

LINK-BELT CO., Chicago, announces that its vertical-capstan electric car spotter will hereafter be furnished "motorized," meaning that the motor will be attached direct to side of spotter housing, with the result that no motor shaft coupling or separate motor base plate will be required. With motor bolted to side of spotter housing, proper initial and permanent alinement of motor shaft is assured; and the plan measurements of foundation required are a minimum.

The motor shaft extends into



a substantial one-piece housing, which contains all the gears, a helical-gear reduction at motor, and a worm-gear set. The gears run in oil, and are readily accessible. The motor is of high-torque fully enclosed type, and can be removed as a unit complete with motor pinion, without disturbing the rest of the machine. The capstan is machine finished to prolong the life of the car haulage rope.

New Jenkins Valves

JENKINS BROS. of New York City announce several additions to its line of bronze gate valves, also a line of extra heavy bronze regrind-renew valves which are made in both globe and angle patterns.

The bronze gate valves are for various working pressures from 125 to 150 lb. steam or 200 to 225 lb. oil, water, gas. Some of the features of the bronze gate valve are: All bonnet threads are in contact with the spindle at all times whether open, closed or intermediate. Guides cast in body keep wedge in line for perfect sealing and when valve is fully open, the wedge is out of the line of flow. Valves can be repacked under full pressure when in the fully open position.

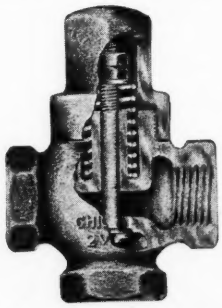
Regrind-renew valves are furnished with screwed ends for 300 lb. steam and 500 lb. oil, water or gas or with flanged ends for 250 lb. steam and 400 lb. oil, water or gas. Stuffing boxes are deep and contain a liberal bulk of lubricated and graphited asbestos packing. Use of a bronze gland or follower compresses the packing, permitting tightness with but slight effort applied to the packing nut.

These valves are so designed that when fully open, the fluid passing through the valve cannot contact the operating threads of the spindle, thus protecting against the accumulation of foreign matter of an abrasive nature.

Tuthill Relief Valves

TUTHILL PUMP CO. of Chicago announces the development of a new relief valve for industrial use, now being introduced to the market in six sizes with two pressure ranges. Model V is built in sizes from ⅜ (Nat. Pipe Thread) to 1½ (Nat. Pipe Thread) for relieving pressures from 5 to 35 lb. Model VH covers the same sizes for relieving pressures from 35 to 100 lb. The only difference between Model V and Model VH is in the springs; and springs are interchangeable.

Features listed by the manufacturer include construction in the



form and shape of a pipe T, reported to insure convenience of mounting; mounting in any position, to insure flexibility; spring compartment of valve vented to valve body proper to insure positive action; and construction of valve with relief pipe at right angles to inlet and outlet to simplify assembly and insure economy of mounting as well as provide freedom from chip-clogging. Replacements are simplified as many parts are common to more than one size.

Electric Weld Stress Reliever

AN ELECTRIC WELD STRESS reliever for pipes ranging from 6 in. to 24 in. is being offered by Detroit Electric Furnace Company.

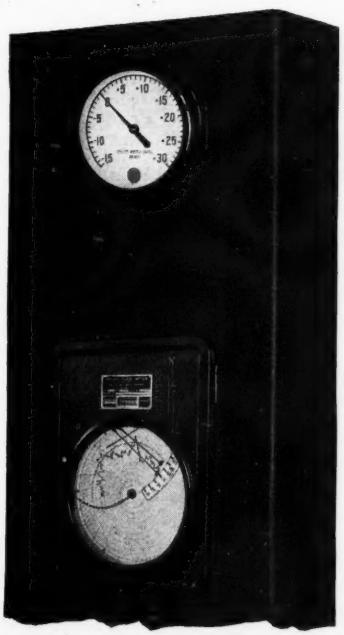
The equipment has been designed for normalizing welded joints in pressure piping systems and is especially useful for field operation, in the opinion of the manufacturers.

Jointed rings of various sizes are provided to fit pipes of diameters described. Power is supplied from a special transformer which, with necessary control equipment, is mounted on a hand-truck for ease of field operation. Induction heat is applied to the areas to be relieved in accordance with predetermined values.

New Meter Combines Feed Water Flow and Boiler Water Level

A NEW METER to indicate and record both boiler water level and feedwater flow has been developed by Bailey Meter Co., Cleveland, Ohio, for use in boiler plants where it is desired to have both an indication and record of these factors on the operating floor.

This combination meter consists of a standard Bailey fluid meter which indicates, records and integrates feedwater flow and a 12-in. indicator with a dial type scale for boiler water level. The indicator is mounted directly above the recording meter on a small feedwater panel as shown in the accompanying illustration. If desired, this combination meter can be located on the individual boiler control panel, where the combination meter is mounted on the right-hand side of two individual boiler control panels standing side by side.



For purposes of comparison, it is valuable to have the records of feedwater flow and boiler water level recorded on the same chart where they are coördinated as to time and can be interpreted easily without reference to additional records or calculations.

Boiler water level being a factor which should be frequently checked by the operators, it is shown on the 12-in. indicator so that the exact position of water in the boiler drum may be easily determined by a glance at the indicating pointer. While it is desirable to provide a direct reading indicator for this factor, it is also important to maintain a permanent and continuous record of the water level. A permanent record of boiler water level definitely shows water level changes which took place within the boiler drum, and is of great assistance in determining the exact source of erratic or faulty operation.

STANDARD OIL COMPANY of Indiana has placed on the market cartridged greases of various grades. The cartridges now being made are of one pound capacity and may be slipped into the barrel of a new type grease gun, making them immediately ready for use. When the operator wishes to change the grade of grease, the cartridge can be quickly replaced by another, and the partly used cartridge is not wasted and does not accumulate dust.

Each cartridge has a sliding bottom which acts as a plunger to feed the lubricant into the high-pressure chamber in the nose of the gun. This method of handling works equally well with fluid or stiff grease.

COPPER ALLOY cylinder heads for increasing power output and reducing carbon formation are announced by Federal Mogul Corpn. of Detroit, and two engine manufacturers have ordered supply for their engines. Test runs have shown carbon deposit reduced 2/3 from cast-iron heads and ½ from aluminum alloy heads. Higher possible compression and lower fuel consumption were also stated to be indicated by laboratory, road and marine engine runs.

News From the Field

LLOYD R. STOWE, formerly manager of the stoker department of the Lacledе-Christy Co., and later in a similar capacity with Johnson & Jennings of Cleveland, has recently joined Combustion Engineering Co. as district manager of the St. Louis territory.

THE TIMKEN ROLLER BEARING Co. announces the appointment of Whitley B. Moore to the position of General Manager of the Industrial Division. Mr. Moore, who is a mechanical engineer, joined the engineering staff of The Timken Roller Bearing Co., at the close of the war. He later became associated with the sales engineering staff, and in 1921 was transferred to the Pacific Coast in charge of sales in that territory. In 1930 he was made Sales Manager, and has remained in that capacity up to the time of his present advancement. John L. Young, until recently District General Manager in charge of the Pittsburgh office of The Timken Roller Bearing Co., has been advanced to the position of Assistant General Manager of the Industrial Division and will move to Canton. Harry D. Robb, sales engineer, has been advanced to the position of District Manager in charge of the Pittsburgh office, succeeding John L. Young. Harry H. Wood, of the engineering and sales staff in Canton, has been transferred to Pittsburgh, and appointed Manager of the Rolling Mill Division.

COMPLETE EXHIBIT of industrial arc welding with material handling hoist has been presented to the Museum of Science and Industry in Chicago by the Harnischfeger Corpn. of Milwaukee, showing demonstrations behind colored glass of the technique employed.

B. W. VINSON CO., INC., Hunt Building, Tulsa, Oklahoma, has been appointed sales representative for The Edward Valve & Mfg. Co., Inc., East Chicago, Indiana, in the Tulsa district.

KENNETH MOLLER, a widely known executive in the field of textile power engineering and at one time a vice-president of the consulting firm of Lockwood, Greene & Co., Boston, Mass., died at his home in Milton, Mass., on Nov. 10. He was 50 yr. of age, and was educated at Harvard University and the Massachusetts Institute of Technology. Before joining Lockwood, Greene's organization, he was designer and engineer for the then Fuel Oil Engine Co., at Providence, R. I. He was responsible for the working out of many power and production problems in the textile field during his association with this house.

LINK-BELT CO. Chicago has acquired the manufacturing and sales rights to the Modern Coal Burner from the Modern Coal Burner Co., which has relinquished its automatic stoker business. Link-Belt Co., announces there will be no interruption or impairment of service to owners of Modern burners and that Modern's present dealers have been asked to continue to handle the line.

AS THE RESULT of the election of officers of standing committees of the American Society for Testing Materials, several new officers have been chosen to direct the activities of the various committees. New officers on committees dealing with power plant problems are listed below. Officers who were re-elected are not included.

Committee A-3 on Cast Iron, Vice-Chairman W. H. Rother, Buffalo Foundry and Machine Co., Secretary, E. K. Smith, Electro Metallurgical Co.; Committee A-5 on Corrosion of Iron and Steel, Chairman, F. F. Farnsworth, Bell Telephone Laboratories; Committee A-9 on Ferro-alloys, Chairman, Charles McKnight, The International Nickel Co., Inc., Vice-Chairman, W. R. Shimer, Bethlehem Steel Co., Inc., Secretary, J. J.

Crowe, Air Reduction Sales Co.; Committee B-1 on Copper Wire, Secretary, J. H. Foote, Commonwealth and Southern Corp.; Committee B-2 on Non-ferrous Metals and Alloys, Vice-Chairman, E. H. Bunce, W. G. Schneider; Committee B-7 on Light Metals and Alloys, Chairman, Sam Tour, Lucius Pitkin, Inc.; Committee C-8 on Refractories, Chairman, R. A. Heindl, Bureau of Standards; Committee D-9 on Electrical Insulating Materials, Chairman, T. Smith Taylor, Washington & Jefferson College, Secretary, E. J. Rutan, The New York Edison Co.; Committee D-19 on Water for Industrial Uses, Secretary, R. E. Hall, Hall Laboratories, Inc.; Committee E-9 on Research, Chairman, P. H. Bates, Bureau of Standards.

JENKINS BROS., Bridgeport, Conn., announces a complete line of friction tapes and splicing compounds including regular commercial grades as well as material to meet the most exacting specifications. These tapes and sealing compounds are being sold under the trade name "Gold Seal."

Gold Seal Friction Tape and Gold Seal Splicing Compound are packed in 1, 2, 4 and 8 ounce rolls. The friction tape is claimed to be strong, "tacky," free from pinholes, non-ravelling and has high insulating qualities. The splicing compound is a high grade rubber insulating tape which fuses instantly and becomes one solid mass which assures a perfect splice and complete protection. It conforms to the specifications of the American Society Testing Materials and American Railroad Association.

ANNOUNCEMENT is made by Link-Belt Co., of Chicago, of the purchase of the physical assets of the Bailey-Burruss Manufacturing Co., 1116 Murphy Avenue, Atlanta, Georgia. All divisions of Link-Belt's Atlanta sales office are being moved to the Bailey-Burruss plant, which will henceforth be known as the Atlanta Plant of Link-Belt Co. The new combined operations will be headed by I. H. Barbee, who is being transferred from the Philadelphia plant of the company. R. L. Lowder and J. R. Martin will continue as a part of the new Atlanta organization, as will J. O. Bailey of the Bailey-Burruss Manufacturing Co.

Charles E. Stuart, president and treasurer of Tyson Roller Bearing Corp. of Massillon, Ohio, resigned as of November 1, after five years spent in organization and operation of the Tyson plant. Mr. Stuart will remain on the board of directors and Russell E. Colgate, who has been chairman of the board, has been elected president and treasurer, succeeding Mr. Stuart. Ralph H. Maxson is executive vice-president in charge of operations; George C. McMullen is vice-president in charge of sales; George Neupower, secretary and E. R. Earnest, assistant treasurer and purchasing agent.

HERMANN VON SCHRENK, consulting timber engineer, St. Louis, Mo., and senior vice-president of the A.S.T.M., was elected to the office of president on October 9. This action was taken by the executive committee to fill the vacancy caused by the death of W. H. Bassett, who passed away on July 21 soon after he took office as head of the Society.

AT A MEETING of the board of directors of the Timken Roller Bearing Co. on October 30, L. M. Klinedinst was elected to the board and also promoted to the office of vice-president in charge of sales to fill the vacancy created by the recent resignation of Judd W. Spray. Mr. Klinedinst has been associated with the Timken Co. for twenty-nine years, having started his business career there as a young man immediately upon completing school. Thirteen years ago, when the company started expanding into the industrial field, he was made general manager of the industrial division, and is largely responsible for the spectacular expansion in the use of Timken Bearings to their present dominant position in nearly every type of industrial equipment. He has been vice-president in charge of all industrial sales since 1930. T. V. Buckwalter, who has been vice-president of the Timken Roller Bearing Co. for several years, was elected vice-president and director of the Timken Steel & Tube Co.

DISTRICT OFFICE of the development and research department of the International Nickel Co., Inc., has moved into larger quarters in the General Motors Building, Detroit, because of increased activity among automotive, agricultural machinery and other durable goods manufacturers in the middle west.

TERRY STEAM TURBINE Co. announces the appointment of Henry D. Bevan as manager of its Philadelphia district office in the Otis Building, 16th and Sansom Streets. Mr. Bevan was formerly assistant manager of the New York office.

NEW EXECUTIVE committee of the Refrigerating Machinery Association, elected at its recent meeting in Chicago is: D. Norris Benedict, chairman, vice-president and general manager, Frick Co. Inc.; A. H. Baer, vice-president, Carbondale Machine Co.; J. M. Fernald, general manager, Baker Ice Machine Co.; G. A. Henser, secretary-treasurer, Henry Vogt Machine Co.; J. I. Lyle, president, Carrier Corpn.; W. S. Shipley, president, York Ice Machinery Corpn.; Emil Vilter, president, Vilter Mfg. Co.

THE IDEAL COMMUTATOR DRESSER Co., Sycamore, Ill., announces that M. A. Buettell, formerly with the Dodge Manufacturing Corp., has joined the Ideal staff as Electrical Engineer.

For the Engineer's Library

MECHANICAL ENGINEERING PRACTICE. By C. F. Shoop and G. L. Tuve. Published by McGraw-Hill Book Co., New York City. Size 6 by 9 in. Cloth, 426 pp. Price $4.00.

Originally published under the title, "Mechanical Engineering Laboratory Practice," the book has been rewritten so as to be essentially a textbook of experimental or test engineering. It is of course fundamentally a manual for laboratory courses yet the contents and material are arranged so as to form a handbook on testing for the practical engineer. Use and characteristics of instruments used for mechanical measurements are included and the laboratory exercises cover lubricants, fluid flow, heat transfer, gases and vapors, pumps, compressors, steam plants and auxiliaries, refrigeration and internal combustion engines. The appendices contain 36 pp. of reference tables, the text is well covered with cross references, and standard test codes are indicated by specific references.

PRACTICAL EVERYDAY CHEMISTRY. By H. Bennett. Published by the Chemical Publishing Co., 175 Fifth Ave., New York City. Size 5½ by 8½ in., 290 pages, cloth bound. Price $2.

How to make what you use is perhaps a more descriptive title of this book which gives in very concise language the working formula with precise and practical direction for making practically everything which can be made from chemicals. Adhesives of all kinds, paints, lacquers, varnishes, inks, lubricants, materials of construction, paper, photography, electroplating, polishes and abrasives, rubber and plastics, soaps and cleaners, textiles and fibers, are but a few of the general headings. The book is a veritable storehouse of how to make what you want and how to carry out practical laboratory experiments in chemistry. No chemical theory is given, the text being entirely devoted to recipes—a modern chemical cook book.

MUNICIPAL ELECTRIC UTILITIES IN MICHIGAN. By Donald M. Whitesell. Published by Michigan Municipal League, Ann Arbor, Mich. Size 8½ by 11 in., paper bound, 104 pp. Price $2.25.

This is a complete report of the municipally owned electric facilities in the state of Michigan and includes a historical background of the organization, administration, and control, methods of financing, rates, plant policies, accounting systems, capacities, output and other statistical data. The question of the right of a municipality to supply electric service to its residents is not discussed as the primary purpose is to present an accurate account and true picture of the operations and accomplishments of the Michigan plants. This has been done very effectively. During the investigation the author visited every plant, thus making it possible to give a much more comprehensive review of plants and conditions than he could have done from printed and published statistics..

DIESEL ENGINEERING HANDBOOK. By L. H. Morrison and T. A. Burdick. Published by Business Journals, Inc., 192 Lexington Ave., New York, N. Y. Size 9 by 12 in., 236 pp. flexible fabricoid binding. Price $5.

Although this is issued as the seventh edition of what was formerly known as the Diesel Power Plant Handbook, the new treatment and text justifies its classification as a new book on Diesels worthy of a place in the bookcase with the best of the books on this subject. It is unfortunate that its awkward size will keep it from this honored position and will banish it forever to the lower shelf with the other journals.

The content and arrangement should be more than sufficient to overcome even this physical handicap for it is truly "a volume dealing with current Diesel practice." The authors both well equipped with design, operating and editorial experience, have spared no effort to make

this a complete and practical text on the modern Diesel.

Theory, economics and design are adequately covered, supported by operating data when necessary and, with the exception of one or two poor line drawings, well illustrated. It is the last part of the book dealing with accessory details, maintenance and operations that will appeal to the operator, however, oil handling and testing, water cooling systems, electrical equipment, etc., are covered in detail. Operation, maintenance and station records cover some forty pages about a quarter of this being devoted to a practical treatment of the indicator and pyrometer. In addition there is a chapter on practical questions and answers and another on the Diesel in transportation. The textbook section is followed by a 78 p. catalog section.

TIMKEN STEEL & TUBE CO. has just published a series of tables which will be convenient for all who have occasion to use steel in multiple lengths. These tables, entitled Multiples At A Glance, are printed in clear type on letter size heavy paper, bound and punched for standard three-ring binders. Ten tables in this booklet enable the steel user to tell at a glance either how long his stock must be to furnish a definite number of multiples, or how many multiples can be cut from a given length of stock, covering multiples up to 50 in number from 1 to 60 in. in length, including common fractions to 1/64 inch. Apart from the simple addition involved when the multiples contain fractions, there is no figuring required when the new Timken multiple table is used. Copies may be secured without cost from the Timken Steel & Tube Co., Canton, Ohio.

WESTON RELAYS is the title of a new, 12-p. bulletin distributed by the Weston Electrical Instrument Corp., Newark, N. J.

On its pages are grouped comprehensive lines of sensitive, toggle, polarized, power and time delay relays, covering a summary of over 30 yr. experience in the development of these devices.

Copies are available by writing the Weston Corp., Newark, N. J.

DEVELOPED to meet many classes of drilling that require a light, mobile pneumatic drill rig, the Rock Master, developed by the Worthington Pump & Machinery Corp., Harrison, N. J., is described in a 4-p. bulletin, W-1200-B9.

FROM Hendrick Mfg. Co., Carbondale, Pa., comes a handsomely printed and illustrated catalog of Mitco open steel flooring, shur-site treads and armogrids showing construction and applications for flooring, stairways and reinforced floors.

HARDINGE CO., York, Pa., has just issued a 56-p. informative catalog, designated as bulletin No. 13C, which is essentially a treatise on grinding and contains much information on subjects such as open versus closed circuit grinding; ball mills versus pebble mills; the Hardinge conical mill; classification, wet and dry; air classifiers for grinding mills; countercurrent classifier for wet grinding mills; chemical and industrial pulverizing methods; ore reduction and concentration; coal pulverization—storage and unit system; the Hardinge constant weight feeder; operating data—specific and general; capacity and dimension tables.

NORTON COMPANY, Worcester, Mass., has prepared for distribution an interesting and novel pencil pointer containing twelve sheets of abrasive material, each one illustrating a type of their floor and stair tile.

"INDUSTRIAL CABLE," a new publication of the General Electric Company, Schenectady, N. Y. describes and lists all standard types of insulated wire and cable used by industrials for transmission, distribution and control, and used on or with electric equipment such as mining machinery, locomotives, arc welders, neon signs, etc.

The publication, of 128 pages does not cover the paper-insulated types of cable, used principally for transmission of large blocks of power at the higher voltages. Such types are custom-built, and generally require the assistance of experienced engineers on both application and installation. "Industrial Cable", GEA-1838, is a companion to Bulletin GEA-1837, an 80-page publication on "How to Select Insulated Cable."

EDWARD'S FORGED strainers for keeping scale, grit and other foreign matter out of traps and valves are described in the November issue of Valve Values issued by Edward Valve & Mfg. Co. Inc., East Chicago, Indiana.

LINDE AIR PRODUCTS CO., New York City, offers two new pamphlets on oxy-acetylene welding practice. One is on Precautions and Safe Practices, covering recent advances in recognized safety requirements; the other is on Gas Cutting of Structural Steel, giving qualification tests for good workmanship. Either or both will be mailed on resuest.

AMERICAN STEAM PUMP CO. has just issued bulletin 426 describing their Redi-Return condensation units. The bulletin contains a full page table of ratings for various discharge pressures and areas of required radiation.

THE EDWARD VALVE & Mfg. Co., Inc., East Chicago, Indiana, has just issued bulletin No. 11-G4, describing forged steel specialties. Featured are gage valves, straight-through valves, strainers, relief valves, special valves for turbine oil lines, and small forged steel stop-check valves.

REPUBLIC STEEL CORP., Massillon, Ohio, has just issued the fifth edition of bulletin 127, entitled Sheet Iron—A Primer. In simple non-technical language it tells the step-by-step story of iron from the mine to the completed sheet. Included is the early history of iron, gage tables and glossary of metallurgical terms.

AJAX FLEXIBLE COUPLING CO., Westfield, N. Y., is distributing a pamphlet designated as a data book on Ajax Flexible Couplings which gives blue print drawings and dimensions for the various types of couplings manufactured by this company.

DESIGN, Installation and Service Advantages of Steel Mixture Furnace Linings and Arches for Modern Boiler Furnaces is the title of the new catalog of McLeod & Henry Co., Troy, N. Y., now being distributed.

HENRY VOGT MACHINE CO., Louisville, Ky., has just issued two catalogs dealing with its class M and class LE four-drum curved tube boilers. Each catalog contains cross-sectional drawings of representative installations in various institutions, industrial plants and utilities.

COCHRANE CORPORATION in its bulletin 700 discusses principles of deaeration and its line of deaerating heaters and steam specialties. It shows why oxygen in solution is the chief cause of corrosion in piping, boilers, etc., giving charts covering various phases of oxygen content in water at different temperatures and its effect upon the speed and amount of corrosion.

ROOTS-CONNERSVILLE BLOWER CORP., Connersville, Ind., has issued its Bulletin 22:23-B10 illustrating and describing the standard and heavy duty types of blowers, including also a general discussion of the inherent characteristics and the operating principle of the rotary positive type of blower.

DIESEL ENGINES of the 4-cycle, single-acting, solid-injection type built in sizes ranging from 175 to 1,500 br.hp. and applicable for direct-connected alternating-current generator drive, gearing to pumps, direct connection to compressors, for belting to line shafting, and for similar work are described in a new catalog by Ingersoll-Rand Co., New York, N. Y.

PROCEEDINGS of the 25th Annual Convention of the National District Heating Association held last June at the Sagamore Hotel, Rochester, N. Y., are now available and may be obtained from the Association headquarters at Greenville, Ohio, for $3. This is a 6 by 9 in. cloth bound volume of 353 pages. Pressure reducing valves, flow meters, hot water heating and temperature controls form a large share of the practical committee reports dealing with plant operation.

REFRIGERATING DATA BOOK. American Society of Refrigerating Engineers, New York City. Size 6 by 9 in., 476 pp. Price $3.50 in the U. S.

In this second edition, which has been largely rewritten, the aim has been scientific thoroughness and practical presentation. Sections on refrigerants and on air conditioning have been amplified, the data on refrigerants being exceptionally complete especially for the new liquids used in domestic units. Various sections are divided by buff pages with an index to each section for convenient reference. The subjects are completely covered and illustrations are informative. Among the authors are A. B. Stickney, W. J. King, Clarence Birdseye, Dr. A. A. Berestneff, Walter L. Fleisher, Donald B. Brooks, C. H. Roe, and C. F. Holske. The committee in charge of publication was composed of A. H. Baer, H. D. Edwards, Crosby Field, Harry Harrison, L. H. Morse, Glen Muffley, A. W. Oakley, A. R. Stevenson, Jr., H. M. Williams, Frank Zumbro and David L. Fiske, editor.

Among the subjects included are domestic refrigeration and units, electric and Diesel engine drives, atmospheric water cooling, brewery refrigeration, train and truck refrigeration, dairy products, dry ice, and fire protection. These are in addition to the thorough treatment of cold storage and ice-making plants, and the equipment and operation of such plants.

Power Plant Construction News

Ark., Caraway—Allen Cooperage Co. plans installation of power equipment, including one-story boiler house, in connection with proposed rebuilding of portion of lumber and stave mill, recently destroyed by fire. Loss about $60,000.

Calif., Arcadia—Steuben Brewing Corporation, 682 South Vermont Avenue, Los Angeles, plans construction of one-story steam power plant at proposed new multi-story brewery on 10-acre tract of land at Arcadia. Electric power equipment will be installed for general brewery service. Entire project reported to cost about $100,000. George W. Harding is company engineer.

Calif., Clarksburg—Amalgamated Sugar Co.. Ogden, Utah, plans construction of power plant at proposed new beet sugar mill on large tract of land acquired near Clarksburg. Entire project will consist of group of 12 to 14 buildings. Majority of equipment will be electrically operated. Mill is estimated to cost over $1,000,000. H. A. Benning is vice-president.

D. C., Washington—Board of District Commissioners, District Building, plans construction of electric power plant to cost about $1,200,000 with equipment, in connection with new sewage disposal works for District, for which a fund of $8,000,000, is being secured through Federal aid. Project will also include pumping plants and equipment to cost about $600,000; sludge digestion tanks and accessories, to cost $1,000,000; and sedimentation tanks to cost about $1,200,000. Entire project is scheduled for completion in 1936. Metcalf & Eddy, Statler Building, Boston, Mass., are consulting engineers.

Ill., Elgin—Illinois Watch Case Co., Dundee Avenue, Elgin, plans installation of electric power equipment in new two-story and basement addition to plant, now being projected. Cost reported over $150,000. L. C. Eppenstein is president.

Iowa, Davenport—Pfeiffer Brewing Co., 3700 Beaufait Avenue, Detroit, Mich., has purchased plant of Independent Brewery Co., Davenport, and plans extensions and improvements with installation of electric power, mechanical handling and other equipment for increased capacity. Cost close to $50,000. Carlton Smith is secretary.

Iowa, Fort Madison—Artesian Ice Co., Fort Madison, has approved plans for new one-story ice and cold storage plant at Avenue O and Nineteenth Street, to cost about $25,000, with equipment.

Ky., Bardstown—Green Brier Distillery and Hobbs Distillery, recently organized by Chicago interests, as affiliated concerns, care of Paul Gerhardt, 64 West Randolph Street, Chicago, Ill., architect, plans installation of electric power equipment and construction of steam power plants at proposed new plants at proposed new plants near Bardstown. Each distillery will cost about $250,000.

La., New Orleans—Metairie Ridge Ice Co., New Orleans, has plans under way for new one-story ice-manufacturing plant with capacity of about 40 tons per day. Cost about $45,000 with machinery. Bids will soon be asked. Irwin Pailet is president.

La., Shreveport—Jackson Brewing Co., New Orleans, La., plans one-story steam power house at proposed new brewery at Shreveport, where site is being selected. Electric power equipment will be installed for brewery service. Entire project reported to cost close to $180,000. J. F. Borleand is general manager.

Mich., Grand Rapids—Leonard Refrigerator Co., Grand Rapids,, a division of Kelvinator Corporation, Detroit, Mich., plans installation of power equipment in connection with expansion and improvement program in porcelain enameling and other divisions. Entire project will cost close to $125,000. Frank D. Brebner is manager of Leonard plant.

Mich., Grand Rapids—Norge Corporation, Grand Rapids, manufacturer of electrical refrigerators, plans installation of power equipment, mechanical handling and other machinery in new one-story factory addition, 100x300 ft. Cost over $50,000.

Mich., St. Clair — North American Distilleries, Inc., Detroit, care of Frederick J. B. Sevald, Buhl Building, Detroit, treasurer and attorney, recently organized with capital of $1,325,000, plans one-story power plant and pumping station at proposed new distillery on St. Clair River, St. Clair. Plant will consist of a number of units, with electric-operated equipment. Cost close to $200,000.

Minn., Glenwood—City Council has plans maturing for new municipal electric light and power plant to cost about $150,000. A bond issue in that amount has been authorized. Financing will be carried out through Federal aid. Burlingame & Hitchcock, Sexton Building, Minneapolis, Minn., are consulting engineers.

Minn., Rochester — Public Utility Board, City Hall, soon takes bids for new one-story municipal power plant at 310 North Broadway. Fund of $95,000 has been arranged for station and equipment. Schuett-Meier Co., 490 North Snelling Avenue, St. Paul, Minn., is engineer. L. A. Cowles is superintendent of utilities.

N. Y., Albany—A.P.W. Paper Co., Albany, manufacturer of tissue papers, plans installation of motors, controls and other electric power equipment, as well as mechanical handling apparatus, in new multi-story paper converting plant on Hudson River, near Bridge Street. Entire project is reported to cost close to $400,000.

N. C., Graham—Joseph R. Morton & Co., Inc., recently organized, plans installation of motors and other electric power equipment in new two-story and basement silk mill, 60x230 ft. Superstructure will soon be placed under way by C. M. Guest & Son, Anderson, S. C., general contractor. Entire project will cost close to $180,000.

Ohio, Dover—Department of Public Service, C. H. Krantz, director, is considering construction of new municipal electric generating plant to cost about $330,000. Federal financing in that amount is being arranged. Welda Hartline is city engineer.

Ohio, Germantown — Germantown Distilling Co., Germantown, recently organized, care of Walker & Norwick, American Building, Dayton, Ohio, architects, plans one-story power house at proposed new distilling plant at Germantown. Electric power equipment will be installed in main distillery. Entire project is reported to cost close to $90,000.

Ohio, Toledo—E. I. duPont de Nemours & Co., Wilmington, Del., plans installation of electric motors, controls and other power equipment in connection with extensions and improvements in plant of Mountain Varnish & Color Works, Tremainsville Road, Toledo, recently acquired. Entire project will cost over $200,000.

S. C., Greenwood—Board of Greenwood County Commissioners, Greenwood, has secured authority from Federal Power Commission to construct and operate hydroelectric generating plant at Buzzard's Roost on Saluda River, about 13 miles from Greenwood, for which fund of $2,767,000 has been secured through Federal aid. Plant will have capacity of about 15,000 kw. Approximately 184 miles of transmission line will be built for service at Greenwood, Laurens and vicinity. County Engineering Department is in charge.

Tenn., Dayton — Tennessee Valley Authority, Knoxville, Tenn., plans construction of new high-tension transmission line over Tennessee River, Hazle Ridge Shoals, on steel towers, in connection with new 22,000-volt transmission line from Athens to Dayton, where service will be furnished in future. Application for permission has been made.

Texas, Avery—City Council will receive bids until Dec. 7 for equipment for municipal waterworks, including pumping machinery and accessories, 50,000-gal. elevated steel tank and tower, pipe lines, fittings, etc. Fund has been arranged through Federal aid. D. C. Wamsley, Thompson Building, Dallas, Tex., is consulting engineer.

Texas, Breckenridge—Brazos River Conservation and Reclamation District, care of State Board of Water Engineers, Austin, recently formed under Legislative action, plans hydroelectric power project and irrigation system in watershed district of Brazos river. It is proposed to build a series of seven hydroelectric power plants with gross rating of 3,000 kw. Project will include transmission lines and power substation. An appropriation of $50,000,000 is being arranged through Federal aid.

Texas, Raymondville — Willacy County Water Control and Improvement District No. 1, Raymondville, C. S. Clark, clerk, has plans under way for new irrigation and water supply system to include central generating plant, about 2500 kw. capacity, and group of electric power substations, for power service for pumping operations. Proposed to ask bids for equipment in near future, including steel and other pipe lines. Fund of $4,853,000 is being secured through Federal aid.

W. Va., Winfield—Kanawha Valley Power Company, Charleston, W. Va., has plans maturing for new hydroelectric generating plant at Federal Dam No. 1, Kanawha River, near Winfield, with capacity of about 26,000 hp. Application for permission has been made. Project will include a transmission line for connection with present system.

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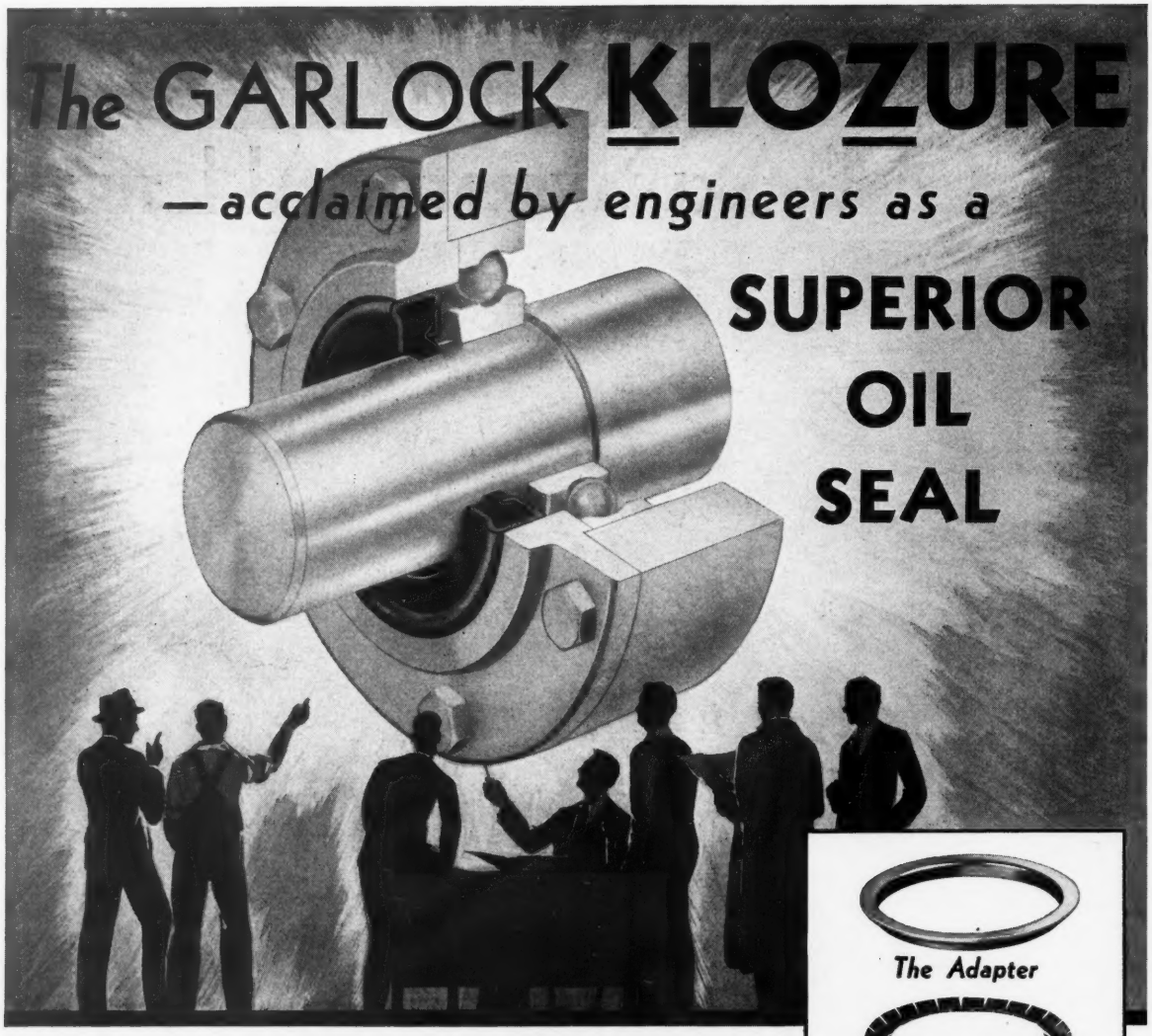

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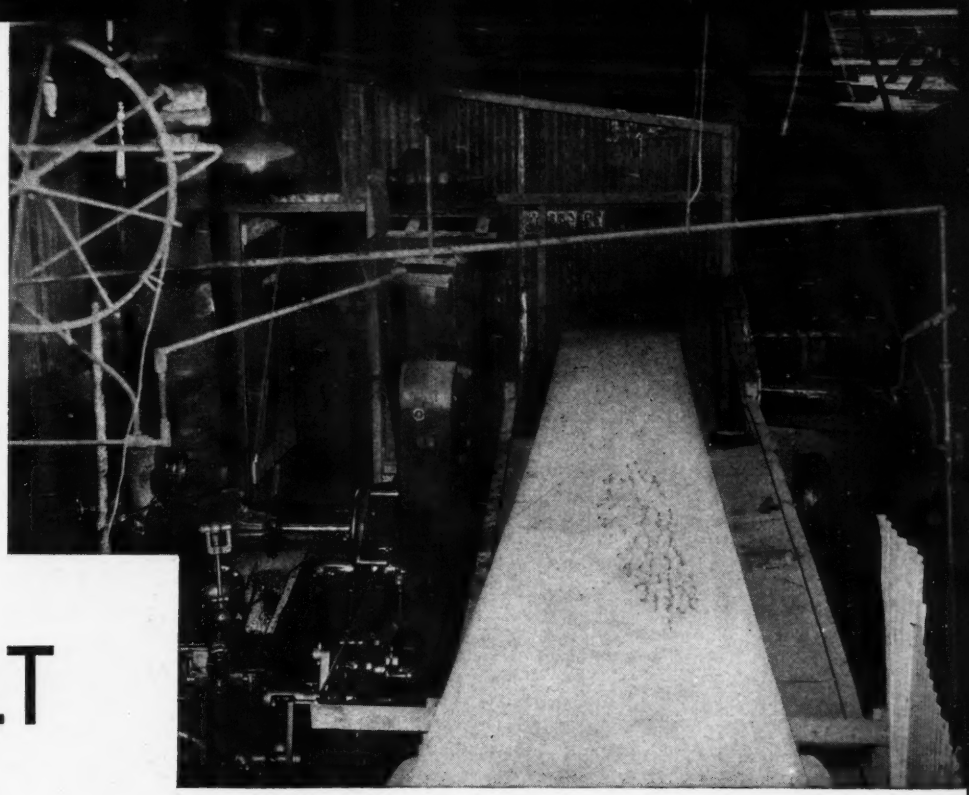

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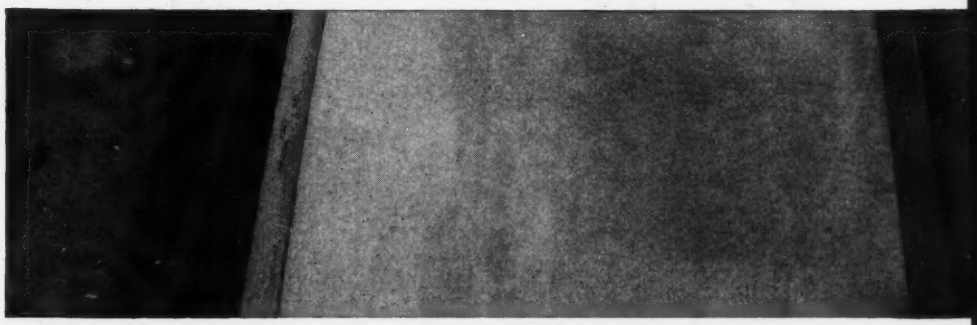

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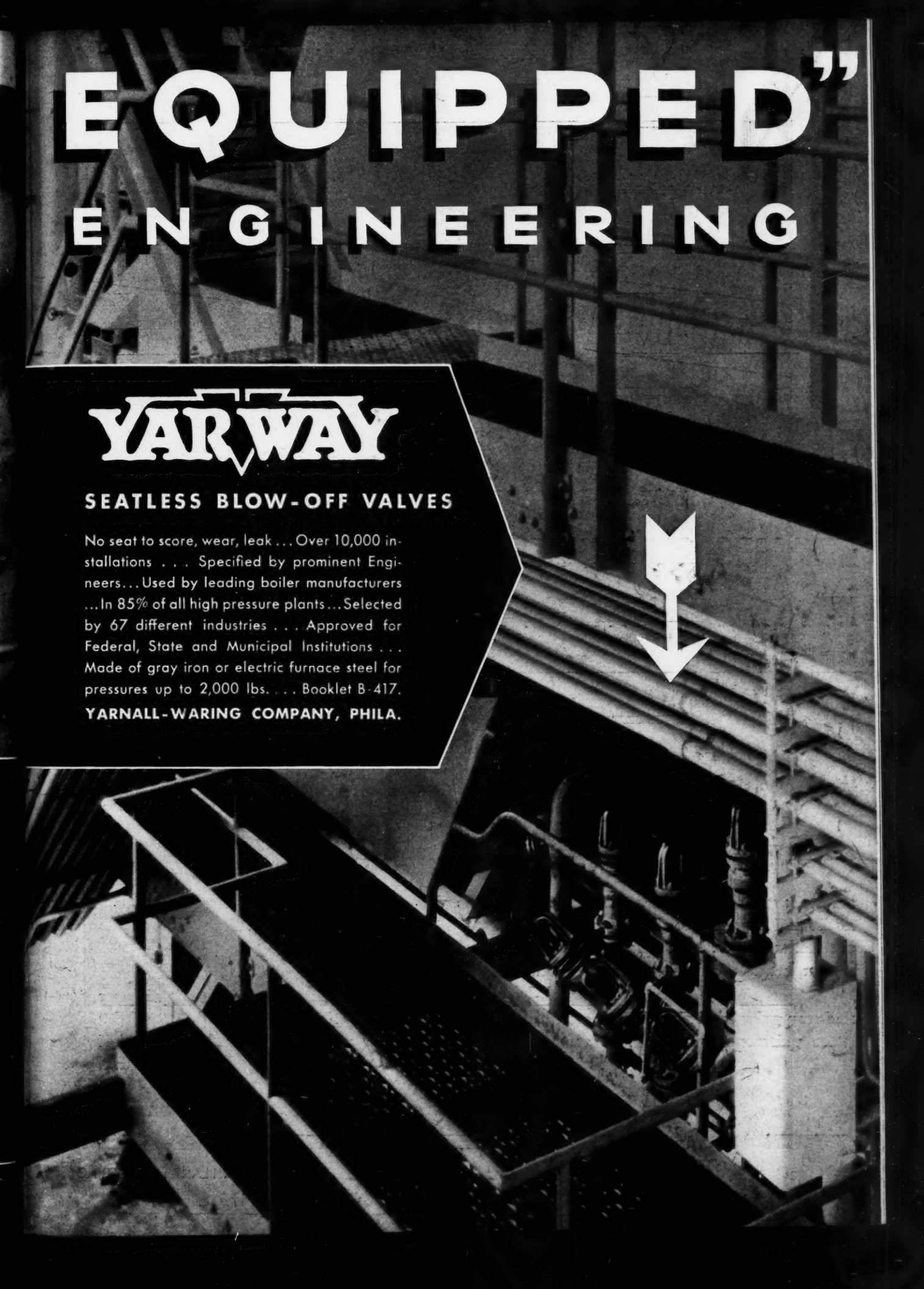
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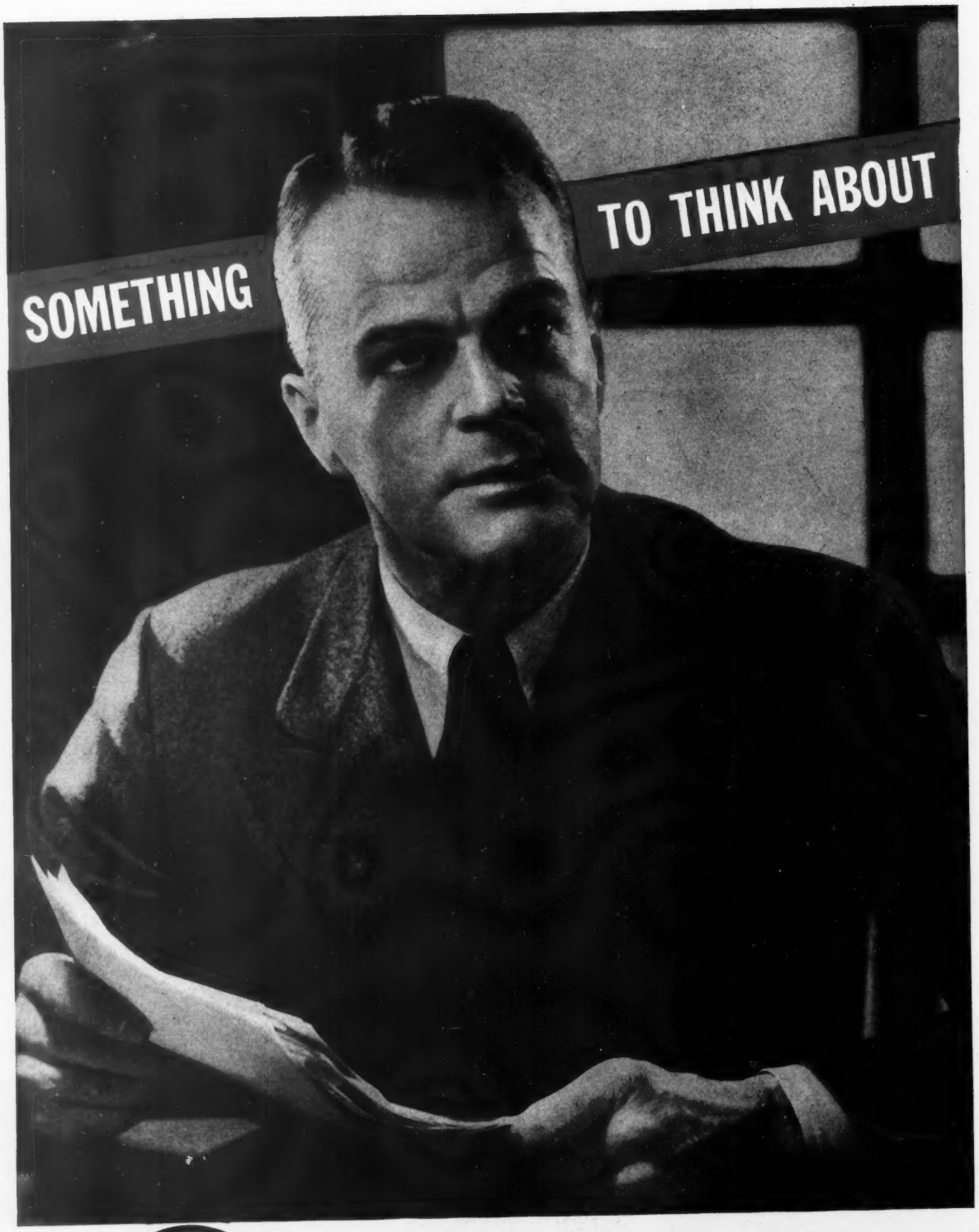

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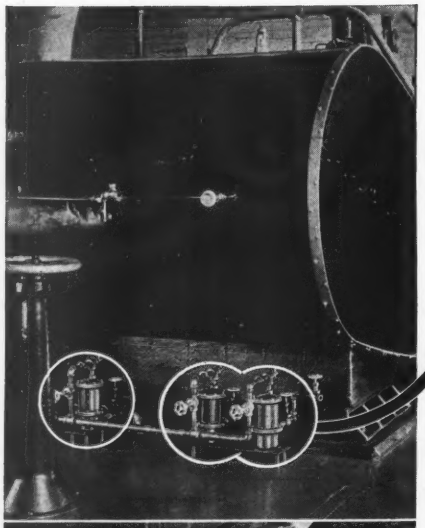
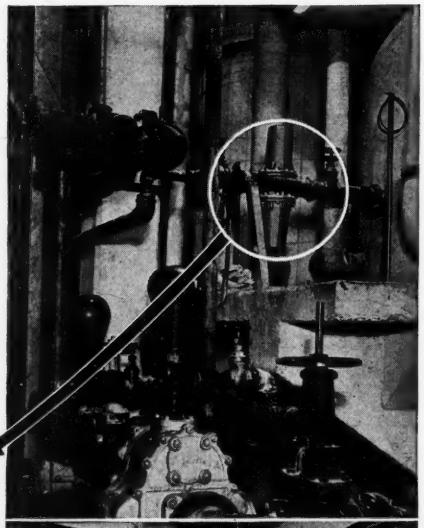
"COMPLETE SATISFACTION"





***the* ARMSTRONG TRAP GUARANTEE**

means satisfaction in all classes of Trap Service such as:

Protecting power plant equipment

• • •

Draining condensate and air from process equipment, water heaters, etc.

• • •

For drip legs on steam lines

• • •

Keeping condensate out of air lines

• • •

Draining radiation —in exposed form or in unit heaters.

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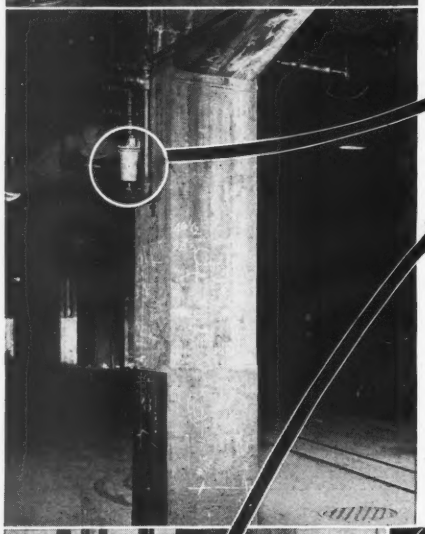
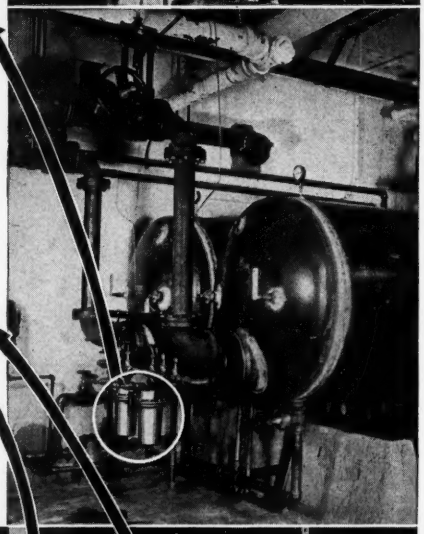
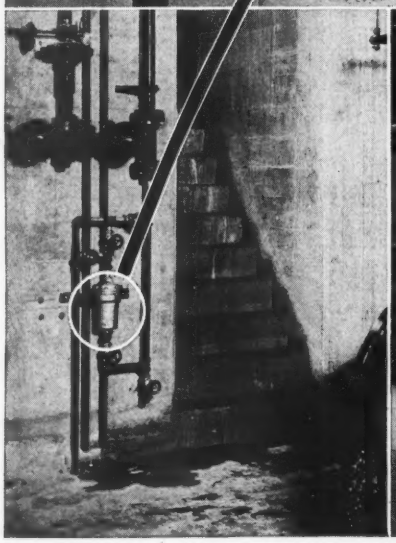
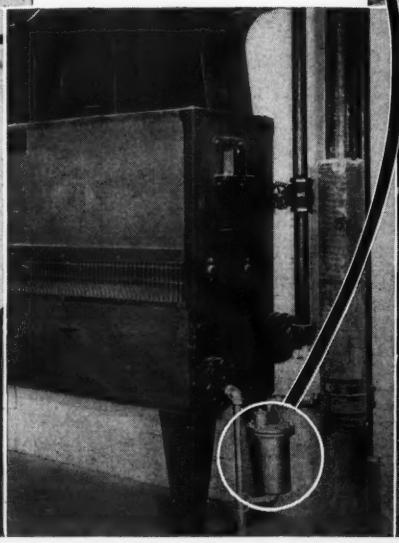
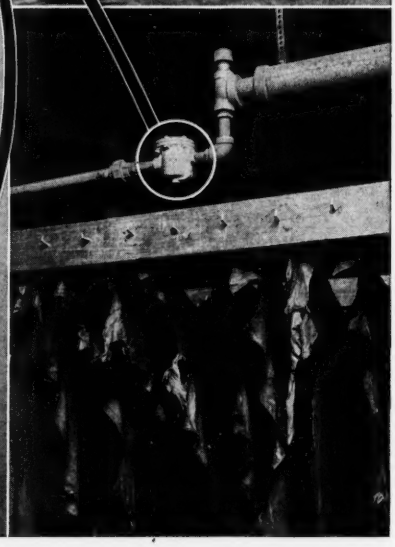
There are more Armstrong traps in service than any other mechanically operated type. Try one for 90 days free.











ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Mich.

Announcing
a New Bailey Boiler Meter for
INDUSTRIAL SERVICE

See this new Boiler Meter at the New York Power Show December 3 to 8, 1934

A NEW BAILEY BOILER METER, simplified in design, sturdy in construction and foolproof in operation, is now available for industrial power plant service. It incorporates a direct reading escapement type integrator, an accurate, sensitive Air Flow Mechanism, a neat appearing dust proof pressed steel casing and a simplified, powerful Steam Flow mechanism with interchangeable head chambers.

This new meter greatly simplifies central station economy methods and places them within easy reach of the small industrial boiler plant. It provides an easily understood, sure fire method of reducing power costs.

Every engineer and executive responsible for steam power costs should investigate this meter. Write for your free copy of Bulletin No. 45.

D-30

BAILEY METER COMPANY

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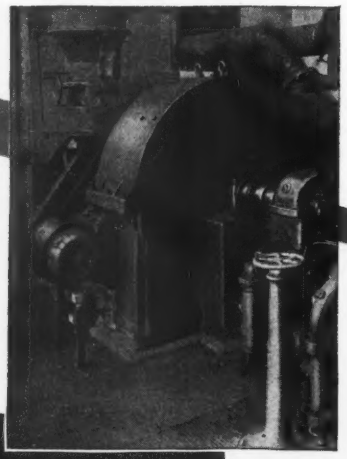
Bailey Meter Company Limited, Montreal, Canada

BAILEY METERS

BOILER METERS
COMBUSTION CONTROL
MULTI-POINTER GAGES
FEED WATER CONTROL
SMOKE DENSITY RECORDERS
FLUID METERS
PYROMETERS
RECORDERS

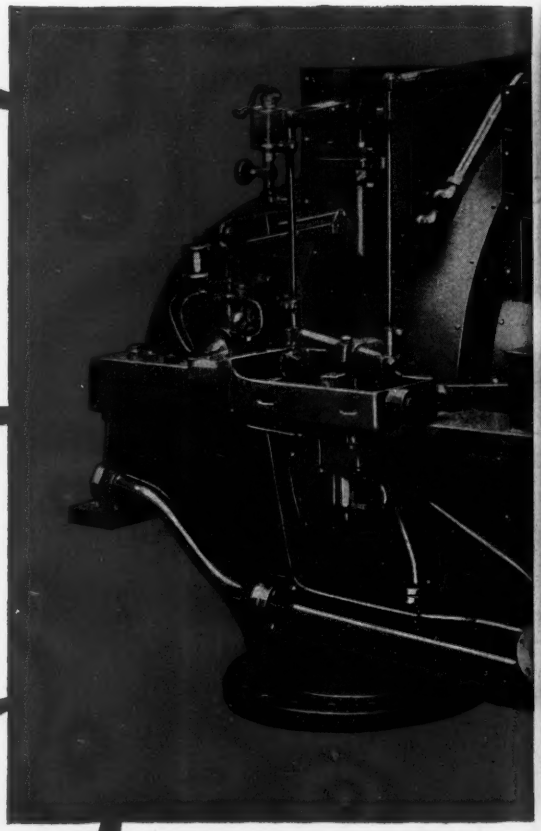
WHY These G-E Steam

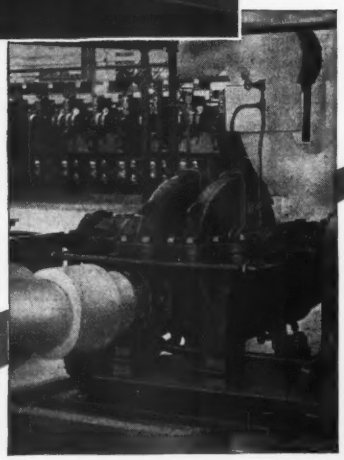
G-E MULTISTAGE TURBINES FOR MECHANICAL DRIVE



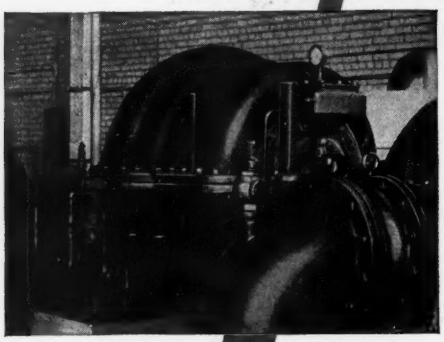
Pulverizers—can be economically driven by G-E mechanical-drive turbines

Fans—an ideal application for G-E turbines





Centrifugal pumps—direct-connected turbines provide reliable, efficient operation

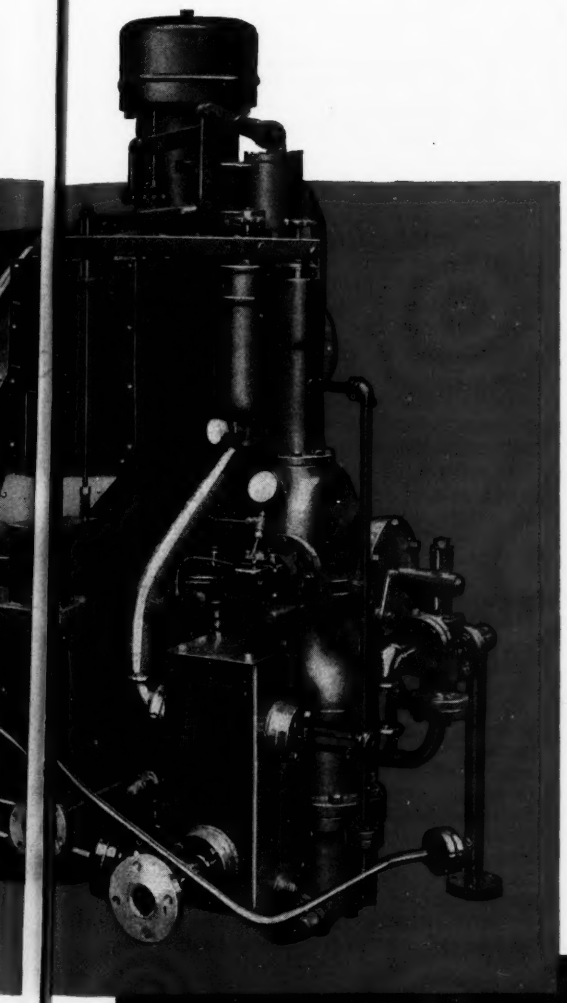


Refrigerating compressors — G-E turbines require the minimum of attention and can be depended on for continuous performance

GE

GENERAL

Turbines Will Save You Money



YOU can effect substantial savings in fuel with G-E mechanical-drive turbines because:

1. Economical operation is assured by their efficient, multistage design.

2. They operate efficiently at partial loads without manual adjustment when equipped with automatic nozzle control, which prevents losses due to throttling (wire drawing) of the steam.

3. Where low-pressure steam is required for process or heating, the steam performs double service; it produces power in the turbine, and then is used for heating, thus improving the over-all plant economy.

4. Where a surplus of low-pressure steam exists, it can be used to produce power by admitting it to an intermediate stage of the turbine. The power thus obtained, and which would otherwise be lost, increases the plant efficiency.

General Electric manufactures a complete line of small multistage turbines — with or without extraction features — to meet almost any requirements for power output or steam demand. A G-E turbine specialist will gladly explain the advantages of G-E turbines and assist you in selecting the proper unit for your requirements. For particulars, call the nearest G-E office or write to General Electric, Dept. 6B-201, Schenectady, New York.

For Driving

PUMPS — COMPRESSORS
FANS — LINE SHAFTS
BLOWERS — GENERATORS

General Electric Company
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I should like to receive copies of descriptive publications GEA-2024 and GEA-2044 covering G-E multistage turbines for mechanical drive.

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E L E C T R I C

TO BE SEEN AT

REPUBLIC INSTRUMENTS

REPUBLIC FLOW METERS CO. and

TWO LEADERS JOIN FORCES TO RENDER A GREATER SERVICE

Announce New Line of Products

Smoot Engineering Corporation, one of the leading designers and builders of control equipment, has joined forces with the Republic Flow Meters Company, pioneers in the industrial instrument field. The plant of the Republic Flow Meters Company in Chicago has been enlarged by the addition of a third unit to accommodate the Smoot Engineering Corporation whose entire plant, engineering staff and general offices have been moved to Chicago.

This alliance of engineering and manufacturing resources brings to industry, an organization capable of rendering a greater and more complete service in the field of measurement and control. This service is now available through a nation-wide organization of sales and service engineers.

During the past two years, to insure sound, progressive engineering, Republic has enlarged its research facilities, and brought together an even larger staff of research and design engineers. As a result, Republic and Smoot are displaying in Booth No. 6 at the National Exposition of Power and Mechanical Engineering, a complete line of new and redesigned instruments and controls.

Visit Booth No. 6

A NEW REGULATOR FOR INDUSTRIAL PLANTS

A new Smoot regulator known as "Series 50" has been designed primarily for the control of industrial boilers. It embodies all the qualities of sensitivity, power, speed and stability which have earned such an enviable reputation for Smoot regulators among central station operators. This new "Series 50" Smoot regulator brings central station efficiency to the small industrial power plant. It will control furnace draft—boiler air—oil flow—stoker speed or fuel feeder speed.

This new regulator uses either water or oil pressure as a source of operating power. It is equipped with a built-in relay cylinder which will produce ample power to operate dampers or other control devices on industrial boilers. The power requirement does not affect the sensitivity, speed or stability of this regulator.

New Design Features "Cartridge Sealed Elements"

The advance line of Republic electrically operated flow meters while retaining the same basic principle of operation include many engineering features new in the field of instrument design. Each actuating element has been built into a metal cartridge, protecting it against dirt, moisture and abuse. Each "cartridge sealed element" is separate and distinct from every other unit, is interchangeable and can be easily and quickly removed from the instrument panel without disturbing or exposing any other mechanism The indicator scale and recorder chart have uniform graduations and are direct reading. The integrator is a separate instrument of the Watt-hour meter type. Its operation is continuous, not intermittent, and will therefore follow any variation in flow.

Unit Assembly Features Smoot Master Control

Re-designed to permit unit assembly, the Smoot Master Control is now available in any number or combination of control units desired. This new type of assembly permits the selection of those units necessary for the control of any particular installation whether it be the control of a single 250 H. P. boiler or a battery of central station units.

Visit Booth No. 6

REMOTE TYPE LEVEL AND PRESSURE GAUGE

The new Republic liquid level and pressure gauge will measure static pressures — the pressure head or height of liquids in pipes, tanks, reservoirs or streams. The reading instruments, indicator and/or recorder, are electrically operated and may be located any distance from the point of measurement. This new gauge can also be easily adapted to a signal system or the automatic control of pumps or other equipment.

Visit Booth No. 6

Recording Thermometer With Cartridge Sealed Helix

The helical element of the Republic recording thermometer is built into a cartridge sealed element which is mounted directly to the back of the panel. This eliminates all danger of damaging or changing the calibration due to handling. The bulb, capillary tubing and cartridge sealed helix are welded together forming a sealed thermol system. This entire unit can be easily removed from the panel eliminating the necessity of returning the entire instrument to the factory when repairs or recalibration is necessary.

THE POWER SHOW

SMOOT ENGINEERING CORPORATION

A NEW MULTIPLE INDICATOR

The new Republic Multi-point indicator with wide horizontal scales represents the latest development in indicating instruments. It will indicate simultaneously, on separate scales, from two to sixteen units of flow, temperature pressure, percent CO_2, etc., in any combination desired.

Visit Booth No. 6

An Improved Strip-Chart Multiple Recorder

Several important improvements have been incorporated in the Republic strip-chart multiple recorder. This instrument will produce six pen line records simultaneously on one wide strip-chart which is divided into three zones. These records may be any combination of flow, temperature, percent CO_2, etc. The individual "cartridge sealed recording elements" are identical with those used in the individual recorders. Separate indicating scales are mounted above each pen indicating at all times the exact flow, pressure, etc.

Multi-Point Draft and Pressure Indicators

Horizontal scales permit "stacking" desired number of units. Draft and pressure elements employ alum-tanned leather diaphragms the center areas of which are held by pairs of aluminum disks, each supported in vertical position by a long two-point pivot bearing through which diaphragm motion is transmitted. Thus, diaphragms do not support any parts of mechanisms, thus sensitivity is extremely high. Diaphragms being "slack," pressure-measurement function is performed entirely by calibrated phosphor-bronze loading springs. These are of simple flat form, and heat-treated to assure permanence of calibration. Any element can be removed by loosening one screw and one nut, without interfering with adjacent elements. Cases have side plates easily removable for inspecting or interchanging elements, are dust-proof, and are white-enameled inside to aid illumination of translucent scales.

Visit Booth No. 6

SMOOT TURBINE TYPE REGULATING VALVE

This valve is designed for the regulation and control of high pressure, superheated steam or boiler feed water. It is a gradual opening, high lift, balanced valve. The throat of the valve is shaped like a turbine steam nozzle but with a regulated area. The direction of the stream lines in the flow is always parallel to the surface of the valve head and seats, thus permitting a smooth passage with practically no erosive action. The valve stem and discs are a one-piece forging. The valve may be either lever or hydraulic operated. Hydraulic operation is obtained by means of a double acting power cylinder which is mounted on the valve bonnet. These valves are available in any size ranging from ½ inch to 20 inches for pressure from 125 lbs. to 1,500 lbs.

Visit Booth No. 6

A NEW MECHANICAL FLOW METER

Republic announces a new mechanical flow meter which is an extremely simple and accurate flow metering device, designed primarily for those installations where remote registration is not required. The entire instrument is mounted on a 16x24 inch steel panel. The recorder, which has a 12-inch evenly divided chart, the indicator, and the synchronous motor driven integrator are flush mounted on the front of the panel. The meter body, which is of the mercury float type, is mounted on the back of the panel forming a compact, sturdy unit. You will immediately recognize the merits of this new instrument which is outstanding because of its utter simplicity.

Visit Booth No. 6!!
at the Power Show

Inspect the complete line of new and redesigned meters and controls offered by

Republic Flow Meters Co.
Smoot Engineering Corporation

General Offices: 2240 Diversey Pkway., Chicago, Ill.

This Plant Engineer
he installed
TRADE MARK
Rx
REGISTERED
CONTINUOUS
UNRESTRICTED CIRCULATION

is sitting on top of the World

RILEY STEAM GENERATING UNITS

It is the duty of the plant engineer to see that steam is produced at his plant as economically as possible. If obsolete equipment makes this impossible, it is up to him to see that a study is made and presented to his executives showing savings which are possible through the installation of modern equipment and what it would cost to install this equipment. Consulting engineers, because of their wide experience in the preparation of such studies, can profitably be employed to co-operate with the plant engineer in the preparation and proper presentation of these figures.

The plant engineer who does this will be sitting on top of the world when actual savings meet or exceed his anticipated figures. The selection of Riley Steam Generating Units will assure such results with complete satisfaction. Plant after plant has selected Riley equipment because of the satisfactory performance of existing Riley installations. There is a very definite swing to Riley Units. Look over a few of these recent installations listed below.

Riley engineers will be only too glad to aid you and co-operate with you in getting together studies of savings which can be made at your plant through the installation of Riley Steam Generating Units. It is our business to so co-operate with you. Just write to the nearest Riley office and an engineer will gladly call and discuss this matter with you. Of course, there is no charge nor obligation for this service.

MAY WE SEND YOU

A Collection of ⅛" Scale Drawings of some Recent Installations of Riley Units?

We will gladly send you drawings of many of the recent installations of Riley Units together with information about the performance of these units. These drawings will be a valuable addition to any plant engineer's library. Just write the Riley Stoker Corporation, Worcester, Mass.

A Few of the Recent Installations of Riley Steam Generating Units

W. Va. Pulp & Paper Co., Covington, Va.	375,000 lbs. of Steam per hour
W. Va. Pulp & Paper Co., Luke, Md.	375,000 " " " " "
A Large Eastern Oil Refinery	300,000 " " " " "
Kalamazoo Vegetable Parchment Co., Mich.	150,000 " " " " "
Forstmann Woolen Co., Passaic, N. J.	60,000 " " " " "
Forstmann Woolen Co., Garfield, N. J.	80,000 " " " " "
Pennsylvania Sugar Co., Phila., Pa.	300,000 " " " " "
Continental Distilling Co., Phila., Pa.	100,000 " " " " "
Jacob Dold Packing Co., Buffalo, N. Y.	67,000 " " " " "
General Aniline Co., Grasselli, N. J.	65,000 " " " " "
Hamilton Woolen Co., Southbridge, Mass.	70,000 " " " " "
Finch Pruyn Co., Glens Falls, N. Y.	50,000 " " " " "
Columbia University, New York City	100,000 " " " " "
American Oak Leather Co., Louisville, Ky.	34,500 " " " " "
Container Corp., Philadelphia, Pa.	200,000 " " " " "
Container Corp., Philadelphia, Pa.	55,000 " " " " "
Titanium Pigment Co., Sayreville, N. J.	125,000 " " " " "
Savannah Sugar Co., Savannah, Ga.	100,000 " " " " "
Beechnut Packing Co., Canajoharie, N. Y.	40,000 " " " " "
Crompton & Knowles Loom Works, Worcester, Mass.	40,000 " " " " "

RILEY STOKER CORPORATION

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SUPERHEATERS • AIR HEATERS • ECONOMIZERS
WATER-COOLED FURNACES • FLUE GAS SCRUBBERS
STEEL-CLAD INSULATED SETTINGS

DO YOU KNOW how much the quality and economy of your entire plant's lubrication depends on the

STORAGE and HANDLING of LUBRICANTS?

A lubricant in use is nothing more than a flexible, constantly renewing, slippery film placed between moving surfaces to keep them from grinding together with resultant wear, heat, and tremendously increased power consumption.

One basic requirement naturally is that the lubricant must be *clean*. The presence of dirt or moisture in a lubricant has harmful effects which are not generally understood. Care in storage and handling is just as important as clean delivery to your plant.

The following excerpts from a paper prepared by the Technical Staff of the Standard Oil Company (Indiana) are interesting:

"The presence of dirt or moisture may considerably change the chemical nature of lubricants . . . dirt, especially has the effect of converting the lubricant into a grinding compound . . ."

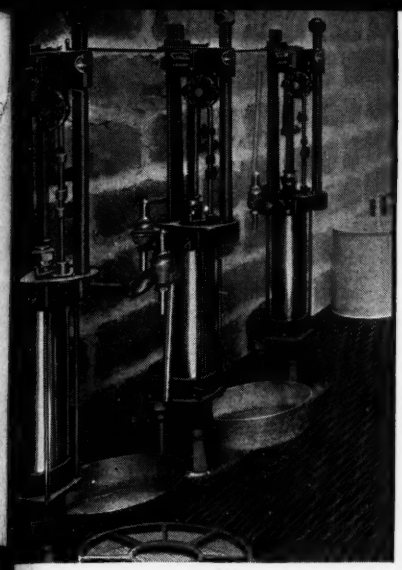
" . . . Lubricants may be stored in too hot or too cold a place where the temperatures may tend to break down any compounding in the lubricant."

"Suitable containers and methods for distributing the lubricants from the oil room to the points throughout the plant where needed, are important considerations in the storage problem. This equipment and method should fit in with a plan of organized responsibility to prevent both waste and neglect."
(several suggestions are given)

(Six factors determine the advisability of tank car storage. These are listed. Both Tank Car Storage and Barrel Storage are treated in detail and practical suggestions given.)

Copr. 1934, Standard Oil Co.

STANDARD OIL COMPANY



(Six precautions are listed which should be observed in unloading tank cars—with specific instructions for unloading tank cars in cold weather.)

"In addition to foreign contaminants, the mixing of different grades of oil will often cause lubrication difficulties . . ."

"Frequent variations in temperature cause 'breathing' to take place in any storage container. . . . Air drawn in due to 'breathing' . . . contains dust and dirt in addition to moisture . . ."
(Practical suggestions are given.)

(Practical suggestions are given for the removal of contaminants, and the rules of safety which must be observed in cleaning tanks.)

"The location of oil rooms and dispensing equipment will usually affect the lubrication obtained, where individual operators are responsible for lubrication."

(The dispensing and distribution of lubricants is completely treated.)

THE paper quoted here is available upon request. Standard Oil (Indiana) Engineers have set down a thorough analysis of the problems met in the Storage and Handling of Lubricants, together with practical, workable suggestions. Various types of storage and dispensing systems are treated, and supervision and the maintenance of accurate records is discussed. Men interested in economical, correct lubrication will be interested in this paper, and should use the coupon below.

Much of the "complication" which has entered the lubrication picture with the development of hundreds of kinds and grades of lubricants—each best adapted to its specifically intended use—can be simplified at the outset through more cleanly and orderly handling.

Generally correct lubrication requires some acceptance of this "complication" that results from the use of a number of different types and grades. And intelligent orderliness is demanded to prevent this complication from resulting in contamination, waste, and unnecessary expense. The *economy* of correct lubrication depends very initially on its *handling*.

The Function of the Lubrication Expert

In his advisory capacity the modern lubrication expert brings you the key to more correct and economical lubrication on every piece of equipment. His background is an experience of refinery, laboratory, and field tests which enable him to offer the most direct and economical solution to every lubrication problem. His duty is to assist you to get the best results in your own plant through personal "on-the-ground" analysis of your problems. In the matter of the storage and handling of lubricants he adjusts his recommendations to the storage facilities available. He is frequently able to simplify your problems—reduce the *variety* of lubricants being used—and at the same time increase the efficiency of your lubrication.

Standard Lubrication Engineers are ready at any time to advise you on specific problems or to conduct general lubrication surveys of your plant and submit their recommendations without obligation.

The
STORAGE and HANDLING
of
LUBRICANTS

Lubrication "Monographs"

Practical papers have been prepared by the Standard Oil Technical Staff covering a wide range of specific lubrication problems. These are available upon request. Please state the particular problems in which you are interested.

The coupon below is for your convenience in requesting the paper quoted here.

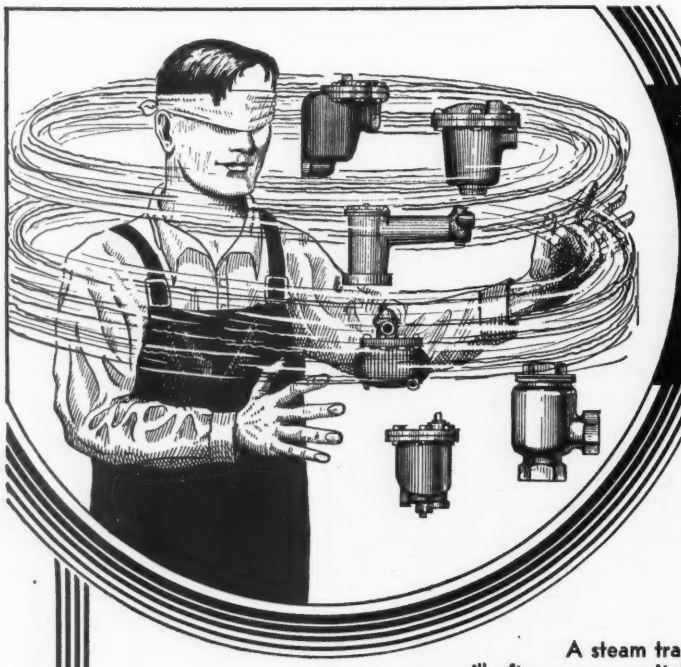
CORRECT LUBRICATION

(INDIANA)

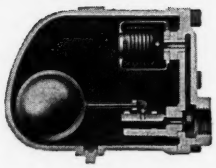
Standard Oil Company (Indiana)
910 S. Michigan Avenue, Chicago, Ill.
Gentlemen:

Please send a complete copy of the paper entitled "Storage and Handling of Lubricants" to:

Name.....*Position*.....
Comoany.....
City.....*State*.....



Don't Try To Pick Steam Traps Blind-Folded!



FTL

A steam trap right for one purpose will often prove unsuitable for another condition. Large sums are wasted by trying to use the same kind of steam trap for every industrial application.

Sarco has long recognized that there is no "universal" steam trap, therefore provides several different types from which to select the one best suited.

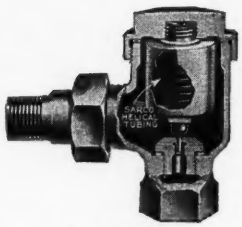
Sarco No. 9-2 Thermostatic Steam Trap leads the line. This is the type which changed engineering practice from old-fashioned group trapping, by means of a few large centrally located traps, to individual trapping (a trap on every coil).

This is the system we recommend for most steam-heated process equipment, operating at pressures from 0 to 125 lbs.

For applications where condensate must be removed as fast as it forms, regardless of the heat units thus wasted, Sarco Float-thermostatic Steam Traps are best adapted. These are preferred, for example, on large unit heaters, hot water generators, ironers in laundries, and calenders (or dry cans) in textile mills.

On extensive systems, where condensate cannot be returned to the boiler, there is no better or more economical steam trap than Sarco No. 8. Even on high pressure (up to 300 lbs.) it discharges only cool condensate with a minimum of "flash" steam.

Put your steam trap problems up to us. Write today for Catalog B-48 and full information. There is no obligation, and our experience in this special field may save you money and help you.



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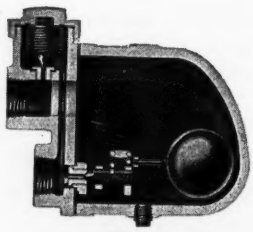
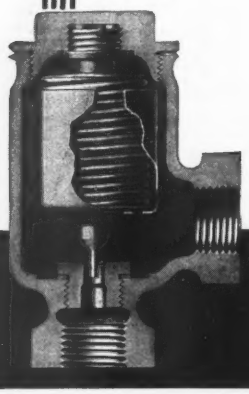
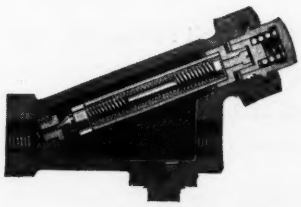


FTH

See us at Booth 81, New York Power Show, Grand Central Palace—Week of December 3rd

No. 9-2





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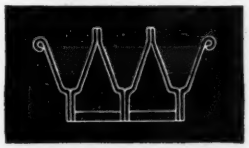
The new
DURO-BRACE TEXSTEEL SHEAVES

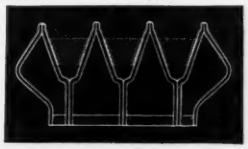
The Allis-Chalmers Manufacturing Company, originators of multiple V belt drives, now offers a new development in sheaves which will withstand the severest duty. • Bending of the outside plate is practically impossible with the new Duro-Brace Sheaves, for in the new design this vulnerable area is braced by a reinforcing convex steel plate, which increases its strength to so great a degree as to eliminate distortion, even under extreme overloads; thus giving a true running drive always. • Duro-Brace Texsteel Drives are 98.9% efficient . . . Require no belt dressing or lubrication . . . Are unaffected by moisture or dust . . . Are Vibrationless, Slipless, Silent, Light and Clean. • Mail us a card asking for Bulletin No. 2188 which sets forth the advantages which Duro-Brace Texsteel Drives offer you in all matters of power transmission, whether they are simple or complex.

★ ★ ★

Former Design: cross-section showing unsupported outside plate.



New Duro-Brace Design: cross-section showing outside plate braced by a convex reinforcing steel plate.



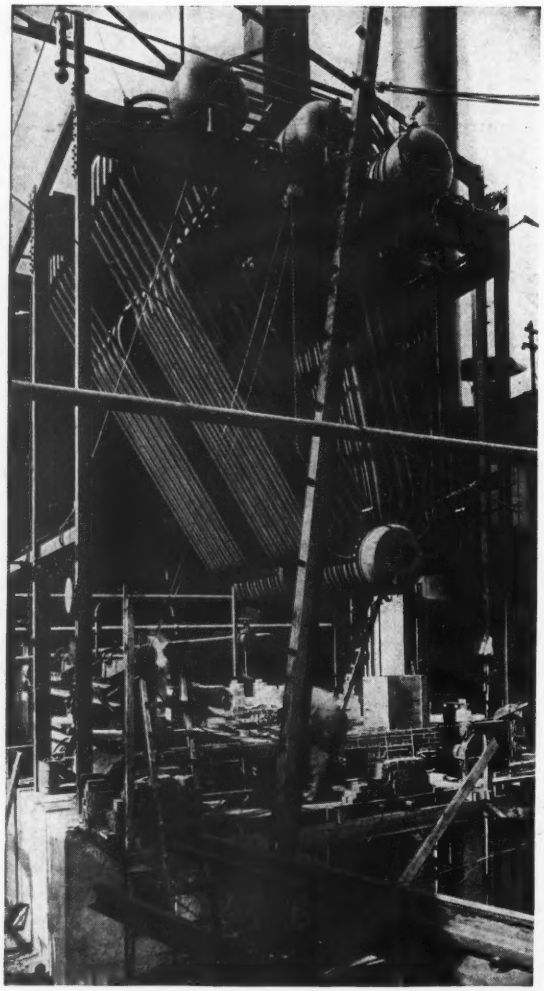
TEXROPE DRIVES

ORIGINATED BY
ALLIS-CHALMERS MANUFACTURING

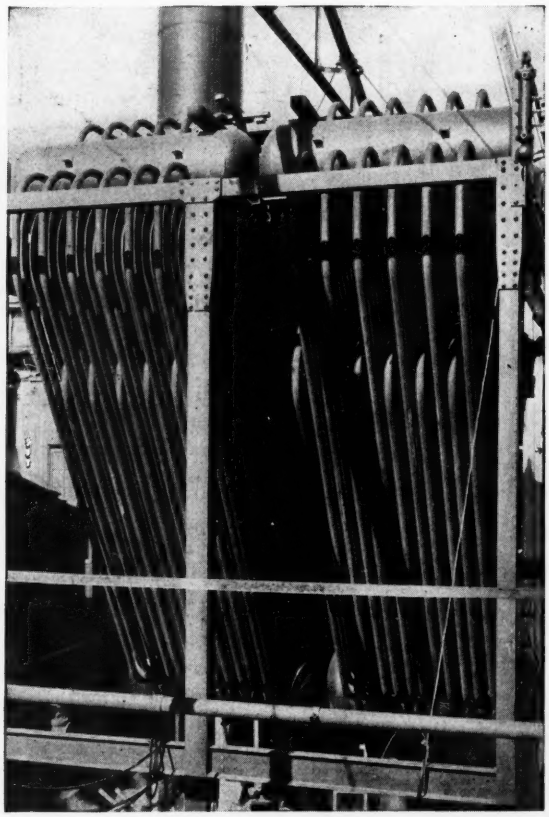
ALLIS-CHALMERS
COMPANY • MILWAUKEE, WISCONSIN

C-E Bent Tube

DESIGN FEATURES . .



Above is shown side view of C-E Bent Tube Boilers, Design VA, now being installed at the Trenton, N. J., plant of the Thermoid Rubber Company. Note that alternate rows of tubes in the first and second banks connect respectively with the front and middle drums, and also arrangement of circulator connections. The effect of these important design features is described briefly in the text on the opposite page.



Two C-E Bent Tube Boilers, Design VA, (2950 sq. ft. of heating surface each) now being installed at the Trenton, N. J., plant of the Thermoid Rubber Company.

COMBUSTION

Boiler—Design VA

. . . reduce turbulence . . . make drier steam . . . equalize water level under changing loads

The C-E Bent Tube Boiler, Design VA, was brought out by Combustion Engineering to meet a demand for a boiler that could be operated over a wide range of output under rapid and extreme load swings, with less turbulence in water level in the respective drums, and with drier steam than was obtained with earlier designs.

These desirable operating characteristics have been effectively obtained by providing for alternate rows of tubes in the front bank to connect respectively with the front and middle drums; alternate rows of tubes in the second bank being similarly connected. Steam liberation from the front tube bank, which does the most work, is thus divided between the two drums. Also important is the fact that the most active tubes discharge steam into the drums at a point above the water line. Separate steam circulators deliver steam from these drums to the outlet drum, and water circulators connect the middle and rear drums to equalize water level when the load changes. In consequence, turbulence of the water in the drums is minimized, oscillations in water level are reduced and less water is carried over into the steam.

Although this new design has been on the market a relatively short time, C-E Design VA Boilers are today serving many prominent industrial concerns, public utilities and institutions. A few of these are named in the panel below. On the opposite page are shown two new units now being installed in the Trenton, N. J., plant of the Thermoid Rubber Company. Scrutiny of these views will show the tube arrangements referred to above.

Data on these and other C-E boilers, firing equipment, heat recovery apparatus and complete steam generating units will be supplied on request. Also the counsel of C-E engineers is available to you and your consultants without obligation. Let us help you to meet your steam requirements in a manner that will be of maximum economic advantage to you.

RECENT INSTALLATIONS
Completed or under construction

	No. of Units	Heating Surface (Each Unit)
Chevrolet Motor Car Company	3	5,040 Sq. Ft.
Colgate-Palmolive-Peet Company	1	4,100 " "
Container Corporation of America	1	7,320 " "
Denver Tramway Corporation	5	7,140 " "
Du Pont Rayon Company	1	8,560 " "
City of Hastings, Neb	1	6,160 " "
Interstate Power Company	1	6,020 " "
Pennsylvania Salt Mfg. Co	1	14,420 " "
Public Service of Colorado	1	8,190 " "
Bath Packing Company	1	5,360 " "
Southern Chemical Cotton Company	1	4,050 " "
Thermoid Rubber Company	2	2,950 " "
The Andrew Jergens Company	1	5,070 " "
U. S. Industrial Alcohol Company	2	10,070 " "
U. S. War Department	2	5,350 " "
Westinghouse Air Brake Company	2	7,570 " "
Jeddo-Highland Coal Company	2	7,026 " "
Mayer & Company, Inc	1	4,920 " "
New York Central R. R. Company	1	5,140 " "
The Chesapeake Corporation	1	7,050 " "
Columbus Ry. Pr. & Lt. Company	1	18,300 " "
Adolph Coor Company	1	5,170 " "
Industrial Cotton Mills, Inc	3	3,560 " "
Westinghouse Elec. & Mfg. Company	1	4,920 " "

COMBUSTION ENGINEERING COMPANY, INC.

200 MADISON AVENUE, NEW YORK

Canadian Associates, Combustion Engineering Corporation, Ltd., Montreal

C-E

A-195

IN THE NEW POWER PLANT of THEO. HAMM BREWING COMPANY

THOROUGHLY modern in every respect, the new power plant of Theo. Hamm Brewing Co., St. Paul, Minn., includes a complete installation of Brown Instruments.

The new power plant burns approximately 2,500 tons of coal per year less than the old plant, a saving of about $12,000 annually.

We are indeed proud of the part entrusted to Brown Indicating and Recording Pyrometers, Flow Meters, CO_2 Meters, Pressure and Liquid Level Gauges. In the operation of this new plant the instruments instantly impart to the operators the proper information as to steam flow, temperatures, pressure, liquid levels, etc., that enables them to secure high fuel economy and maintain maximum efficiency.

Mr. W. H. Lang, Supt., says:

"The installation of Brown Instruments in our power plant is very satisfactory. We feel that probably the best proof of this is the fact that we have ordered several additional instruments for applications in other parts of the plant."

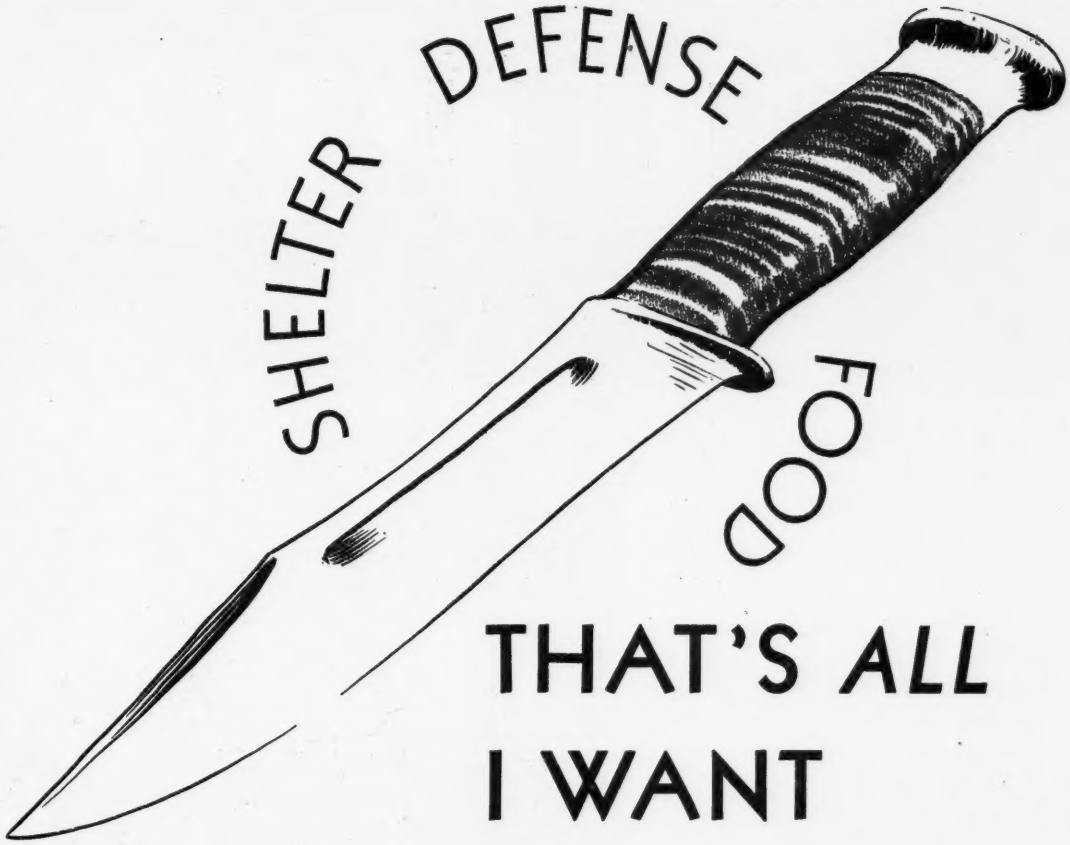
Plan now for lower steam costs—Our engineers will be glad to consult with you. Ask for a copy of the Brown Power Plant Instrument Data Book.

THE BROWN INSTRUMENT COMPANY
4491 Wayne Avenue Philadelphia, Pa.
Branches in 22 Principal Cities

See Brown Instruments in operation at Booth No. 48 at The New York Power Show—Dec. 3rd to 8th, 1934.

Brown Instruments

"to measure is to economize"



THAT'S *ALL* I WANT

"3-POINT LUBRICATION" COMPARED WITH OTHERS

(1) The right kind of CRUDE is important. Some types are better adapted to certain uses than others. Pure Oil Crude comes from many fields in nine states, not from a single area producing only *one* kind of Crude that must be recommended and sold for *every* lubrication need.

(2) Good REFINING is vital. No commercially practical refining process can add missing properties to inferior crudes. But even the best Crude must be correctly Refined to prevent loss of inherent lubricating values. Pure Oil modern Refining methods preserve and *improve* the lubricating qualities of Pure Oil superior Crudes.

(3) Scientific APPLICATION is equally important. Good Crude and good Refining go for naught unless skilled engineering selects the best types of lubricant for the particular job in question. Pure Oil Engineers are not only lubrication experts, they have had extensive experience in practical plant operation problems.

Most things are pretty simple when they are boiled down . . . If you were lost in the woods you'd have three needs—defense, shelter, food. If you could have but one tool would it be a gun? An ax? No. A stout knife. A simple tool, but it serves all purposes.

Yes, things boil down simply . . . The selecting of Lubricants is another example. Volumes are written on the subject. Yet the three essentials are covered in the Pure Oil "Three-Point Lubrication" story, briefed in the three paragraphs at the left, and the one solution is Pure Oil, don't you agree? For the simple, sure answer to the lubrication question, call in a Pure Oil man for a talk.

The PURE OIL *Company*

PRODUCERS, REFINERS AND MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS

REFINERIES:

Marcus Hook, Pa. Heath, O. Toledo, O.
Muskogee, Okla. Midland, Mich.
Smith's Bluff, Texas Cabin Creek Jct., W. Va.

PURE

BRANCH OFFICES:

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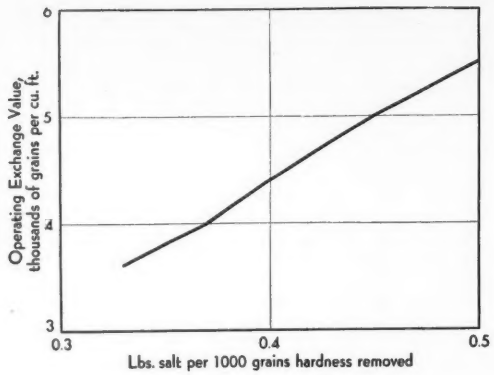
NRA

(B-956)

SUPER

A NEW AND

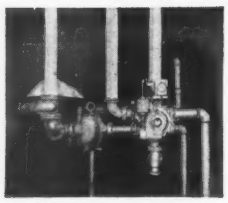


• This is an important announcement to every owner of water treating equipment, and to every plant that needs such equipment. Permutit now offers an improved zeolite for water softeners . . . of higher capacity, of greater ruggedness, of lower salt requirements per 1,000 grains of hardness removed.

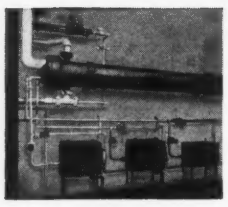
ZEO-DUR, Permutit's greensand zeolite, has long been known for its resistance to wear and tear. Now, by a series of special treatments, it is made more rugged than ever before, and at the same time its water softening power is increased. We call this new zeolite SUPER-ZEO-DUR. The maximum capacity of SUPER-ZEO-DUR is 75% greater than that of regular greensand zeolite. Or to put it another way, even if operated at sharply reduced salt requirements, Super-Zeo-Dur is substantially higher than ordinary greensand. The relation between salt consumption and capacity is shown in the chart.

LASTS LONGER . . . Super-Zeo-Dur is tougher and more resistant to abrasion than any other zeolite. Special treatments cleanse and purify it so that the final granule is tougher than ever before. At the same time, these treatments greatly increase its capacity.

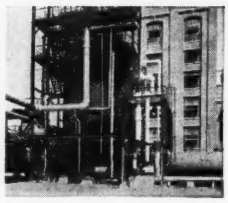
CUTS COSTS NOW ... Repeated tests prove that Super-Zeo-Dur requires less salt than ever before to obtain water of zero hardness. This economy is maintained in large and small plants alike. The owner saves not only on the cost of his salt, but also on the freight cost of transporting it and the space cost for storing it.



PERMUTIT AUTOMATIC ZEOLITE WATER SOFTENER. Lowers the cost of producing soft water. No over-running. No under regeneration. Automatic controls can be applied to existing equipment. Write for "No Scale, No Sludge, No Mud."



PERMUTIT CONTINUOUS BOILER BLOW-OFF EQUIPMENT. For continuously maintaining the desired concentration in boilers, with recovery of heat from the blow-off water. Write for Booklet.



PERMUTIT HOT LIME SODA WATER SOFTENER. . . . For reducing total solids, particularly in waters of high bicarbonate hardness. Write for information.

CO_2 INDICATORS AND RECORDERS. Ranarex . . the fully mechanical CO_2 Indicator and Recorder. Strong, rugged, yet with accuracy of 0.3% CO_2. Normal time lag of less than one minute. Fuel savings quickly return its cost. Write for bulletin describing operation.

ZEO-DUR

BETTER ZEOLITE

HAS A RESERVE CAPACITY

This new zeolite has a flexible capacity. If you need extra water softened, just use proportionately more brine. This flexibility creates a reserve capacity for softening water . . . to be used for emergencies or for increased capacity in the future . . . and requires only a normal increase in brine (see chart).

SUPER-ZEO-DUR has been thoroughly tested by long runs at all ranges of softening capacity. It is a definite money saver. For instance, to remodel existing zeolite water softeners to automatic control, and refill them with Super-Zeo-Dur, will repay, on the average, 50% per year of the conversion cost. Beside this cash saving, the fully automatic plant operation is simpler and more positive, there is no danger of overrunning, and there is a reserve water softening capacity at hand to meet peak or emergency demands.

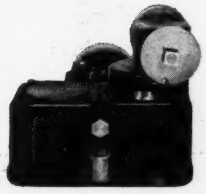
Obviously, with this new zeolite and fully automatic control, the new Permutit zeolite water softeners are the last word in fool-proof, low cost operation.

Super-Zeo-Dur is the most recent addition to the line of Permutit products. There is Permutit equipment to meet every water treating requirement. Some of these products are featured below.

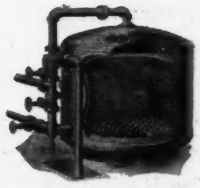
We are always at your service to advise you on your water problems, to produce for you water of the specifications which you desire. Write for information on any of the Permutit products. And be sure to find out just how much money a refill of Super-Zeo-Dur in your present equipment will save you! No obligation . . . just write The Permutit Company, 330 West 42nd Street, New York, N. Y.

Permutit *Water Treating Equipment*

HEAT EXCHANGERS. Turbulence scrubs off stagnant water film from surfaces, permits higher rate of heat transfer. Design allows for unit increases in capacity. Uni-metal construction avoids electrolytic corrosion. Ask for information.



CHEMICAL FEEDS. For feeding sulphates, phosphates and other solutions in exact proportion to flow of water. Also constant flow types. Special acid feeds. Feeds for dry materials such as clay. Bulletins available.



FILTERS. Both pressure and gravity types, in all sizes, for removal of dirt, color and turbidity. Coagulation equipment. Activated carbon filters for removal of bad taste and odor. Send for a free copy of "Water Filters & Filtration Equipment."

SINGLE VALVES. To simplify the operation of zeolite water softeners. Made in all sizes, they can be used with existing equipment. Single valves for filters, too. We'll be glad to send you information and prices.

What power leaks will it uncover?

How about your steam plant? Have you had it thoroughly diagnosed? Are you *sure* that important economies made possible by the use of increased steam pressures and temperatures, the use of bleed steam for heating and process work, the use of air pre-heaters and other modern equipment *are not being overlooked?*

The cost of steam or power used to produce any one of your products may be a fraction of a cent, insignificant... yet at the end of a year's operation your power losses may aggregate thousands of dollars. Isn't it possible that power represents your greatest opportunity for cutting costs?

Hundreds of alert executives, unwilling to longer face power plant uncertainties have called in Austin Engineers for a thorough diagnosis... gained by applying an experienced outside viewpoint to their problems... stopped leaks caused by "White Elephant" methods of making steam, electricity, compressed air and other power services.

Such a diagnosis will help determine whether your present plant can be profitably modernized or whether new construction is most advantageous... and whatever the answer may be Austin is organized to economically carry on through the entire operation from diagnosis to steam in the boilers.

There is an Austin office near you. Consultation involves no obligation. Write, phone or wire.

THE AUSTIN COMPANY

ENGINEERS AND BUILDERS · Cleveland, Ohio · 16112 Euclid Ave. · Telephone GLenville 5400

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THE AUSTIN METHOD

Savings *quickly pay for*

BETHLEHEM-DAHL OIL BURNERS

The Bethlehem-Dahl Mechanical Oil Burning System offers savings in steam-generating costs so substantial as to justify a thorough investigation by all power plant operators.

These savings result, not only from the elimination of fuel waste during "dead hours," labor for ash-handling, and maintenance of stokers and of coal- and ash-handling equipment, but also from increased boiler efficiency. In the aggregate the savings are so substantial that they quickly pay the cost of installing Bethlehem-Dahl Oil Burners. Savings during the first year well above the cost of installation have been reported by enthusiastic users of the Bethlehem-Dahl System.

Investigate the economies and other advantages that follow the use of oil fuel. Without obligation, a Bethlehem engineer will gladly make an estimate of the savings to be had at your plant through the adoption of the Bethlehem-Dahl Mechanical Oil Burning System.

Two groups of Bethlehem-Dahl Oil Burners in the Power House of the U. S. Immigrant Station, Ellis Island, New York Harbor.

BETHLEHEM STEEL COMPANY

GENERAL OFFICES: BETHLEHEM, PA.

SEND FOR THIS BOOK!

Mail the coupon below and we will send you a copy of our booklet, describing in detail the advantages of oil fuel and the Bethlehem-Dahl Mechanical Atomizing System.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Gentlemen: Please send me booklet on Bethlehem-Dahl Oil Burners.

NAME.....

ADDRESS.....

.....

COMPANY.....

POSITION.....

Machinery, Equipment and Supplies Used in The Production, Transmission and Utilization of Power

Air Compressors
De Laval Steam Turb. Co.
General Electric Co.

Air Preheaters
Air Preheater Corp.
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Ash Handling Systems
Combustion Eng'r'g Co.
Link Belt Co.

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Belting
United States Rubber Co.

Blowers, Fan and Furnace
Air Preheater Corp.
De Laval Steam Turb. Co.

Blowers, Forced Draft, Portable, Pressure and Coal
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Blowers, Tube
Bayer Company

Blowers, Turbine
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Smooth-On Mfg. Co.
United States Rubber Co.

Gauge Cocks
Ernst Water Col. & Gage
Lonergan Co.
Nason Mfg. Co.

Gauges, Draft, Liquid Level
Bailey Meter Co.
Brown Inst. Co.
Ellison Draft Gage Co.
Foxboro Co.
Nason Mfg. Co.
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Lonergan Co., J. E.

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American Dist. Steam Co.
Yarnall-Waring Co.

Lining, Furnace
Norton Co.

Lubricants
Pure Oil Co.
Socony-Vacuum Oil Co.
Standard Oil Co.
Texas Co.

Lubricating Paste
Garlock Packing Co.

Lubricators
Lunkenheimer Co.
Powell Co., Wm.
Manzel Bros. Co.
Williams Valve Co., D. T.

Mechanical Draft Apparatus
Buffalo Forge Co.

Meters, Air and Gas
Republic Flow Meters Co.

Meters, Boiler
Bailey Meter Co.
Brown Inst. Co.
Republic Flow Meters Co.

Meters, Coal
Bailey Meter Co.
Republic Flow Meters Co.

Meters, Water and Steam
American Dist. Steam Co.
Bailey Meter Co.
Brown Inst. Co.
Republic Flow Meters Co.

Meters, V-Notch
Yarnall-Waring Co.

Monel Metal Rings, Rods, Castings, Forgings, Tubings, Sheets, Wire and Wire Cloth
International Nickel Co.

Motors
Allis Chalmers Mfg. Co.
General Electric Co.

Nozzles for All Purposes
Marley Co.
Yarnall-Waring Co.

Oil and Grease Cups
Lonergan Co., J. E.
Lunkenheimer Co.
Powell Co., Wm.
Williams Valve Co., D. T.

Oil, Coal and Gas Burning Equipment
Bethlehem Steel Co.

Oiling Systems
Burt Mfg. Co.

Oil Purifiers
De Laval Steam Turb. Co.

Oil Removing Filters
Scaife & Sons Co., Wm. B.

Oil Tanks
Manzel Bros. Co.

Oils, Lubricating
Pure Oil Co.
Socony-Vacuum Oil Co.
Standard Oil Co.
Texas Co.

Packing, Asbestos, Flax and Metallic
Crane Packing Co.
Garlock Packing Co.
Johns-Manville Corp.

Packing, Metallic, For Condenser Tubes
Crane Packing Co.
Garlock Packing Co.

Packing, Piston and Rod, Valve Stem
Crane Packing Co.
Garlock Packing Co.
Johns-Manville Corp.
United States Rubber Co.

Packing, Sheet Valve, Pump
Garlock Packing Co.
Jenkins Bros.
Johns-Manville Corp.
United States Rubber Co.

Pipe Coils
Superheater Co.
Vogt Machine Co., Henry

Pipe Covering
American Dist. Steam Co.
Eagle Picher Lead Co.
Johns-Manville Corp.

Pipe Savers
Sarco Co., Inc.

Piping Manufacturing, Fabricating and Contracting
Bethlehem Steel Co.
Crane Company
Timken Steel & Tube Co.

Planimeters
Foxboro Co.

Power Houses, Design and Construction
Austin Co.

Power Transmission Machinery
Link Belt Co.

Pulverized Fuel Equipment
Bethlehem Steel Co.
Combustion Eng'r'g Co.
Kennedy-Van Saun Engrg. & Mfg. Corp.
Riley Stoker Corp.

Pumps, Boiler Feed
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Pumps, Centrifugal
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Pumps, Elevator, Fire and General Service
American Steam Pump Co.
De Laval Steam Turb. Co.
Warren Steam Pump Co.

Pumps, Hydraulic
Warren Steam Pump Co.

Pumps, Oil and Electric
Lonergan Co., J. E.
Manzel Bros. Co.
Warren Steam Pump Co.

Pumps, Power
Warren Steam Pump Co.

Pumps, Turbine
Moore Steam Turb. Corp.

Pumps, Vacuum
Warren Steam Pump Co.

Pumps, Waterworks
Moore Steam Turb. Corp.
Warren Steam Pump Co.

Purifiers, Boiler Feed
Permutit Co.
Scaife & Sons Co., Wm. B.

Purifiers, Steam
Blaw-Knox Co.
Marley Co.

Pyrometers
Brown Inst. Co.
Republic Flow Meters Co.
Superheater Co.

Recording Instruments
Foxboro Co.

Refractories
Eagle-Picher Lead Co.
Johns-Manville Corp.
Norton Co.

Regulators, Damper
Atlas Valve Co.
Brown Inst. Co.
National Regulator Co.

Regulators, Fan Engine
Atlas Valve Co.
Foster Engineering Co.
National Regulator Co.

Regulators, Feed Water
Atlas Valve Co.
Bailey Meter Co.
Brassert & Co., H. A.
Chaplin-Fulton Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.

Regulators, Pressure
Brassert & Co., H. A.
Chaplin-Fulton Mfg. Co.
Foster Engineering Co.
National Regulator Co.
Sarco Co., Inc.
Squires Co., C. E.

Regulators, Temperature
Atlas Valve Co.
Brassert & Co., H. A.
Brown Inst. Co.
Foxboro Co.
National Regulator Co.
Sarco Co., Inc.

Scale Removers, Mechanical
Lagonda Mfg. Co.
Pierce Co., Wm. B.
Roto Co., The.

Scale Removing Compounds
Sugar Beet Products Co.

Seamless Tubes
Timken Steel & Tube Co.

Separators and Extractors, Steam and Oil
Blaw-Knox Co.
Marley Co.
Williams Valve Co., D. T.

Shafting
Timken Steel & Tube Co.

Sodium Aluminate
National Aluminate Corp.

Soot Blowers
Bayer Company

Sprocket Rims
Babbitt Steam Spec. Co.

Stacks, Metal
Vogt Machine Co., Henry

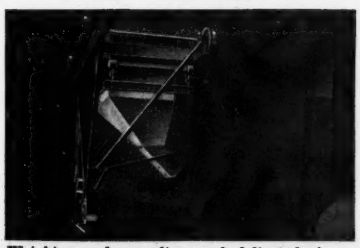
Stair Tread, Non Slipping
Blaw-Knox Co.
Carnegie Steel Co.

Use LINK-BELT COST-REDUCING CONVEYORS for Coal and Ashes Handling

The Link-Belt Automatic Under-Feed Screw Type Stoker. A rugged, dependable unit, simply designed for efficient, fool-proof service.

The Peck Overlapping Pivoted Bucket Carrier. The one machine handles both coal and ashes.

An efficient, economical coal handling installation of moderate size, for storage, and handling to stoker hoppers.



Weighing and recording coal delivered, is a check on plant efficiency—use Link-Belt Traveling Weigh Larry.

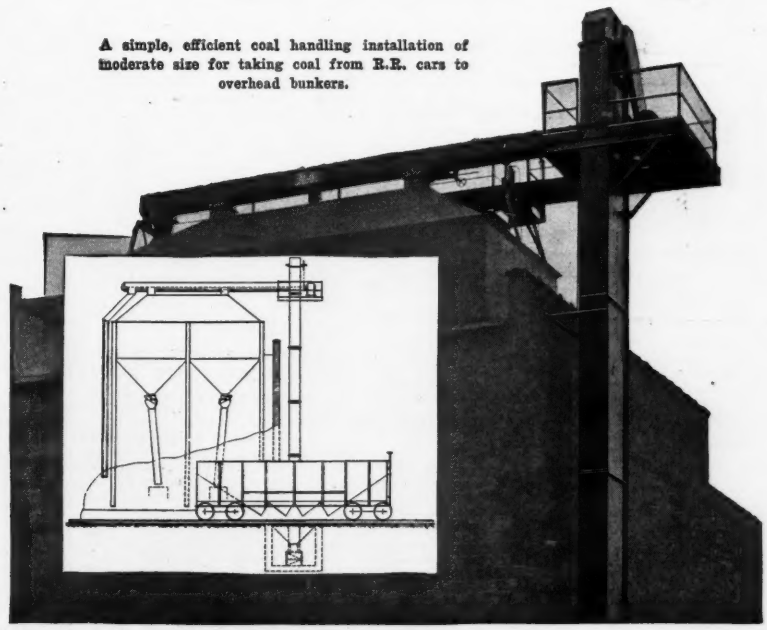
Steam and power costs can be reduced through greater efficiency in handling coal from cars to boiler and in ashes disposal. Are your methods in line with today's best practice? Consult an experienced Link-Belt engineer. Link-Belt products include: elevators and conveyors of the bucket, belt, flight, apron, and gravity-discharge-bucket types; underfeed screw type stokers; skip hoists; weigh larries; coal crushers; water intake screens; locomotive and crawler type cranes; portable conveyors; feeders; bins; gates; etc. Send for catalogs.

LINK-BELT COMPANY

Chicago Philadelphia Indianapolis San Francisco Toronto
Offices in all Principal Cities

5033-B

A simple, efficient coal handling installation of moderate size for taking coal from R.R. cars to overhead bunkers.



See Our Exhibit at the NEW YORK POWER SHOW, Grand Central Palace, New York, Spaces 285 and 286, December 3 to 8

Steam Traps
American Dist. Steam Co.
Armstrong Mach. Wks.
Nason Mfg. Co.
Sarco Co., Inc.
Squires Co., C. E.
Williams Valve Co., D. T.

Stokers, Mechanical, Overfeed and Grate
American Engrg. Co.
Babcock & Wilcox Co.
Combustion Eng'r'g Co.
Detroit Stoker Co.
Riley Stoker Corp.

Stokers, Underfeed
American Engrg. Co.
Combustion Eng'r'g Co.
Detroit Stoker Co.
Link Belt Co.
Riley Stoker Corp.

Strainers
Sarco Co., Inc.

Superheaters, Steam
Babcock & Wilcox Co.
Riley Stoker Corp.
Superheater Co.

Tachometers
Brown Inst. Co.
Foxboro Co.

Tanks
Graver Tank & Mfg. Corp.
Scaife & Sons Co., Wm. B.
Vogt Machine Co., Henry

Thermometers, Dial
Sarco Co., Inc.

Thermometers, Recording and Indicating
Brown Inst. Co.
Foxboro Co.
Sarco Co., Inc.

Traps, Compressed Air, Vacuum
Armstrong Machine Wks.
Nason Mfg. Co.

Traps, Steam, Radiator and Return
Armstrong Machine Wks.
Nason Mfg. Co.
Sarco Co., Inc.

Tube Cleaners, Boiler and Condenser
Liberty Mfg. Co.
Pierce Co., Wm. B.
Roto Co., The.

Tubing
Crane Company
Timken Steel & Tube Co.

Turbines, Hydraulic
Allis Chalmer Mfg. Co.
De Laval Steam Turb. Co

Turbines, Steam
Allis Chalmers Mfg. Co.
De Laval Steam Turb. Co.
Elliott Co.
General Electric Co.
Moore Steam Turb. Corp.
Terry Steam Turbine Co.

Unions
Atlas Valve Co.
Dart Mfg. Co., E. M.
Edward Valve & Mfg. Co., Inc.

Underground Heating Systems
American Dist. Steam Co.

Valve Discs
Garlock Packing Co.
Jenkins Bros.
United States Rubber Co.

Valves, Auto. Cut-Off
Edward Valve & Mfg. Co., Inc.

Valves, Blow-Off
Crane Company
Edward Valve & Mfg. Co., Inc.
Fairbanks Co., The
Jenkins Bros.
Lunkenheimer Co.
Powell Co., Wm.
Yarnall-Waring Co.

Valves, Check
Edward Valve & Mfg. Co., Inc.
Fairbanks Co., The
Jenkins Bros.
Kennedy Valve Mfg. Co.
Powell Co., Wm.
Williams Valve Co., D. T.

Valves, Electrically Operated
Fairbanks Co., The

Valves, Float
Atlas Valve Co.
Foster Engineering Co.

Valves, Gate and Globe
Crane Company
Edward Valve & Mfg. Co., Inc.
Fairbanks Co., The
Jenkins Bros.
Kennedy Valve Mfg. Co.
Lunkenheimer Co.
Powell Co., Wm.
Vogt Machine Co., Henry.
Williams Valve Co., D. T.

Valves, Hydraulic
Crane Company
Fairbanks Co., The
Kennedy Valve Mfg. Co.
Vogt Mach. Co., Henry

Valves, Pop Safety
Crane Company
Lonergan Co., J. E.
Lunkenheimer Co.
Powell Co., Wm.

Valves, Plug
Fairbanks Co., The

Valves, Pump
Garlock Packing Co.
Jenkins Bros.
United States Rubber Co.

Valves, Radiator
American Dist. Steam Co.
Fairbanks Co., The
Jenkins Bros.
Kennedy Valve Mfg. Co.
National Regulator Co.
Williams Valve Co., D. T.

Valves, Reducing, Regulating and Relief
Atlas Valve Co.
Chaplin-Fulton Mfg. Co.
Edward Valve & Mfg. Co., Inc.
Foster Engineering Co.
Lonergan Co., J. E.
Powell Co., Wm.
Squires Co., C. E.

Valves, Steel
Crane Company
Edward Valve & Mfg. Co., Inc.
Kennedy Valve Mfg. Co.
Powell Co., Wm.

Ventilating Apparatus
Buffalo Forge Co.
Burt Mfg. Co.
National Regulator Co.

Waste Heat Recovery Systems
Babcock & Wilcox Co.

Water Columns and Alarms
Ernst Water Col. & Gage
Lunkenheimer Co.
Nason Mfg. Co.
Yarnall-Waring Co.

Water Cooling Equipment
Marley Co.
Schubert-Christy Corp.
Yarnall-Waring Co.

Water Purifying and Softening Systems
Dearborn Chemical Co.
Elgin Softener Corp.
National Aluminate Corp.
Permutit Co.
Scaife & Sons Co., Wm. B.
Sugar Beet Products Co.

Water Intake Screens, Clean
Link Belt Co.

Water Screens
Combustion Eng'r'g Co.

Water Testing Equipment
National Aluminate Corp.

Water Walls
Combustion Eng'r'g Co.
Riley Stoker Corp.
Superheater Co.

Whistles
Lonergan Co., J. E.
Lunkenheimer Co.

SIGNBOARD SECTION

RATES FOR ADVERTISING IN THE SIGNBOARD SECTION

CLASSIFIED RATES

Advertisements published in the Signboard Section which come under the classifications of "Positions Wanted"—"Engineers Wanted"—"Salesmen & Agencies"—"Patent Attorneys"—etc., are charged for by the line.

The rate per line for one insertion is—50c

The minimum advertisement accepted is four lines. Classified advertisements are all printed in the same style and sizes of type. No display type is used. Box numbers can be used. Replies are forwarded promptly.

DISPLAY RATES

The unit of space used for advertisements under the headings of "Equipment Wanted"—"Equipment for Sale"—"Technical Books"—"Professional Cards"—etc., is the column-inch which is one column (2¼ in.) wide and one inch deep. The basis rate is $5.50 for one column-inch in one issue. This basis rate decreases as larger space is used.

Quotations will be sent promptly on request for any desired size of space or number of insertions.

Display headings, bold-face or italic type and signature cuts are permissible in Display Advertisements.

EQUIPMENT FOR SALE

"Ideal" for Lower Motor Maintenance Costs

Commutator and Slip Ring Resurfacers and Grinders. Mica Undercutters—Blowers, etc.

IDEAL COMMUTATOR DRESSER CO.
1033 Park Ave., Sycamore, Ill.

ENGINEERS WANTED

WANTED: A large coal producing company in the Appalachian Field is interested in a graduate Mechanical Engineer with several years practical experience in combustion work on diversified stokers in Ohio, Michigan, or Indiana territory. Apply in writing to "Appalachian Producer", care: POWER PLANT ENGINEERING, 58 W. Jackson Boulevard, Chicago, Ill.

EQUIPMENT WANTED

WANTED—COCHRANE hot water softener or equal, to be a 10000/10000 gallon per hour design "TS" combination softener for soda lime treatment having a capacity for treating 10,000 gallons of raw water per hour and heating 10,000 gallons of condensate per hour. Heaters in the softener to be tray type or jet type. In your reply give complete details of equipment offered, condition it is in, location and if it can be inspected. Address Box 1210, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

SALESMEN AND AGENCIES

RESPONSIBLE COMPANY doing national business desires progressive sales agents or jobbers. Territorial protection on non-competitive, patented products, now being used by many foremost industrial and power plants in the United States. When replying state qualifications and lines now handling. Box No. 1207 c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

NATIONALLY PROMINENT line of engineering and maintenance products for all kinds of manufacturing plants. Salary, expense account and commission if satisfactory after ninety days trial. Liberal commission paid weekly first ninety days. Permanent, lucrative connection. Continental Asbestos & Refining Co., 1 Madison Ave., New York, N. Y.

POSITIONS WANTED

POWER PLANT ENGINEER, or EFFICIENCY ENGINEER College graduate desires to make connection with a Utility or Industrial Company which needs the services of an engineer with executive ability. 10 years' experience in all phases of the Power Plant Engineering field. Please reply to Box 1214, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

A FULLY EXPERIENCED ENGINEER who has had charge of machine shop, boiler room and engine room lost his position which he had held for several yrs. by being laid up from an auto accident which was in no way his fault. He has held responsible jobs in paper mill, machine tool and general power plant work. Able and anxious to prove his ability and worth. Write to Box 1216, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

POSITIONS WANTED

GRADUATE ELECTRICAL ENGINEER. Texas A. & M. College Degree. Varied mechanical and electrical experience with power plants and railroads both in the shop and drafting room. Well versed in advanced mathematics. Prefers employment with electric railroad or power plant but will be glad to accept work with steam railroad or any kind of electrical work. Any job to start. Available immediately and will go anywhere. Please write to Box 1213, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

17 YEARS' EXPERIENCE as power plant engineer. Can operate a power plant from boiler room to switchboard. Will go anywhere. Eager to prove ability in any power plant job. Address Box 1212, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

MASTER MECHANIC WITH WIDE EXPERIENCE in power plant and general maintenance, also construction, drafting of plans, and handling of help. Wishes connection with industrial plant, hospital, hotel or office building. Best of References. Reply to Box 1215, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

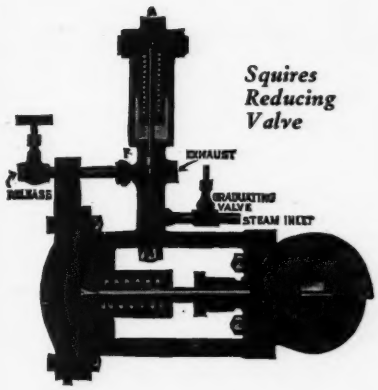
ENGINEER OF WIDE EXPERIENCE available for power plant or other engineering work. Through 16 years' experience has progressed upward from fireman, boiler room engineer, maintenance foreman and shift foreman and has for the last eight and one-half years worked as combustion and test engineer supervising the efficient operation of the several plants of a large company. 37 years of age and in excellent health. Is a graduate of the Hays Institute and of the I.C.S. steam engineering course. A well equipped man who constantly studies his profession and can furnish convincing references from employers. Willing to work in any part of the country. Box 1217 c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

It Saves Fuel Dollars because It Works FAST and WEARS LONG

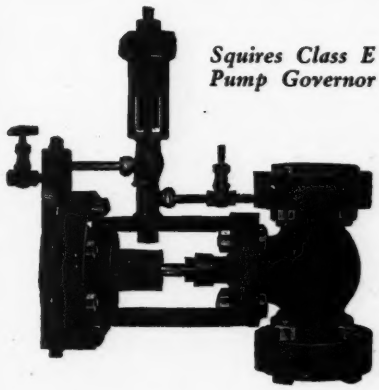
Foremost companies throughout the country use the Genuine Squires Steam Trap because its simplicity and many outstanding construction features help guarantee maximum savings.

The Genuine Squires Trap, for example, checks steam waste because it is quick opening and quick closing, insures a positive water seal at all times. Simple, husky construction enables it to work with little attention. The illustration below shows how easily the valve and seat may be replaced for any desired steam pressure without breaking any pipe connections.

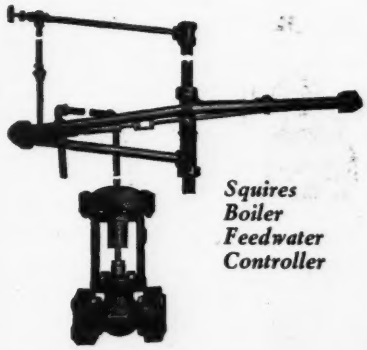
Write for Catalogue E-1 if you are not already familiar with the many advantages of the Genuine Squires Trap, Reducing Valve, Pump Governor, Boiler Feedwater Controller and other steam-saving specialties. It points the way to greater profits from the power plant.



Squires Reducing Valve



Squires Class E Pump Governor



Squires Boiler Feedwater Controller

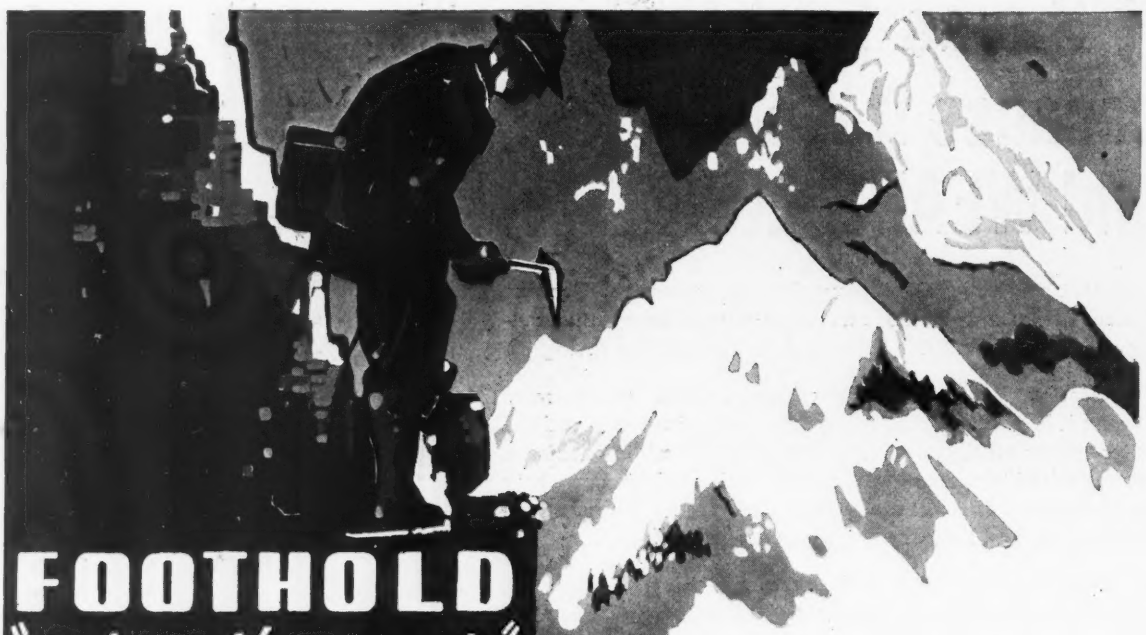
Insist on the Genuine Squires

TRADE MARK

Steam Specialties

THE C. E. SQUIRES COMPANY

E. 40TH ST. & KELLEY AVE., CLEVELAND

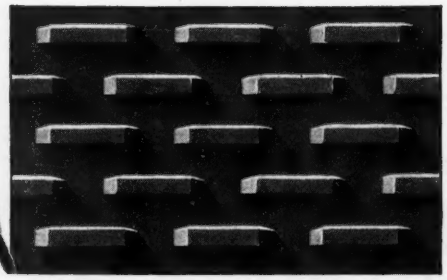


FOOTHOLD
"makes the grade"

Where the foot can be planted firmly, the man can move with confidence. Where footing is uncertain, grave hazards may result. Let your workers walk in safety. Install Carnegie Floor Plate. On elevated platforms, foot bridges, shop and boiler room floors, stair treads, sidewalk doors and openings, and the like, the non-slip, easy-draining, raised pattern surface of this modern material makes walking comfortable and labor efficient. It reduces the chance of accident, at little cost. A considerable range of widths and thicknesses are offered. Full information mailed upon request.

CARNEGIE STEEL COMPANY • PITTSBURGH
Subsidiary of United States Steel Corporation
277

CARNEGIE
Floor Plate



GOT A *Big Job* FOR A SMALL VALVE?

USE THESE VERSATILE CLAMP GATE VALVES

Sturdy . . Economical . . Compact . . You can find many new uses for these sturdy valves in small sizes

● These valves handle more *different* jobs than you would give them credit for at first glance and they are more compact, more reasonable in price than a valve of ordinary design. In all sizes, the replacement of one small part will provide a new thread bushing for the stem. This adds length of life, speeds repairs. All outside screw and yoke valves of this type have stem threads entirely *outside* the body, not subject to action of liquid or gas in the line. Crane Clamp Gate Valves come in a *complete line of small sizes*, either in screwed or flanged ends, and brass-mounted for general industrial use or all-iron construction for resistance to corrosion. Outside screw and yoke, inside screw, or quick-opening design.

COMPLETE IN SMALL SIZES FOR THESE APPLICATIONS:

Steam Lines	Cold Water Lines	Lubricating and Fuel Oil Lines
Hot Water Lines	Air Lines	Caustic Lines (All-Iron)

Visit Crane Booth No. 53 at the Power Show, December 3 to 8, inclusive

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVE., CHICAGO, ILLINOIS

NEW YORK: 23 W. 44TH STREET

Branches and Sales Offices in One Hundred and Sixty Cities

Crane Clamp Gate Valve No. 487½—Brass Mounted, Outside Screw and Yoke

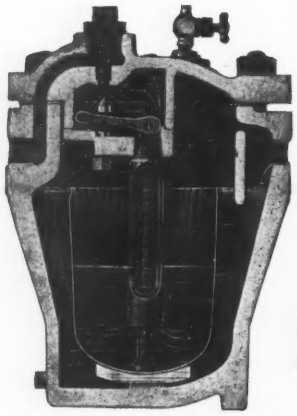
Crane Clamp Gate Valve No. 490½—Brass Mounted, Inside Screw

Crane Clamp Gate Valve No. 490—Brass Mounted, Inside Screw

Crane Clamp Gate Valve No. 486½—Brass Mounted, Outside Screw and Yoke

NASON *Titan* TRAP

Oil Pre-Heater Installation



Sectional view of TITAN Trap with float down-valve open-pressure forcing condensate in float out through passages.

OVER 4 Years' Constant Use -

and still performing dependably!

A typical example of how Nason TITAN Traps "stand the gaff" is evidenced by a trap fuel oil pre-heater installation in a large New York office building. This trap, in operation continuously for four years, without any repairs whatever, has been draining the oil pre-heater for 2,000 boiler horsepower, and is still giving uninterrupted service.

With steam pressure on trap at 165 pounds per square inch, the record of service throughout the four-year period was:

Bunker oil pre-heated: 13,140,000 gallons.
Water drained: 22,000,000 pounds.
Number of operations: 21,024,000.
Rate of operations: Two per minute.

And after this remarkably long and severe service for this particular application, *the valve is still perfectly tight.*

It is this typical record of enduring dependability, with maintenance practically eliminated, that has made Nason Traps preeminent in their field.

Among the many advantages of the Nason TITAN and TINY Traps are: higher in capacity per dollar of cost, not affected by pulsating pressure, scientifically designed to eliminate wire-drawing, will handle air and other non-condensable gases, all internal parts of non-corrodible materials, entire mechanism can be removed without taking trap from line, light in weight and small in size, simple and durable in construction.

It will pay you to learn about the utility and economy advantages of the proper Nason Trap for your particular application. Descriptive Catalog: "The Solution of Your Condensation Problem" will be mailed gladly upon request.

Originators of the Steam Trap

NASON
MANUFACTURING CO.

Only complete line of traps

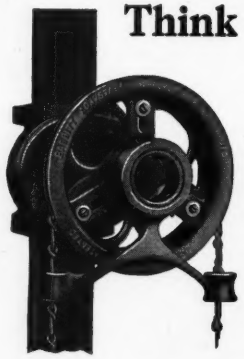
NASON STEAM TRAPS: "DETROIT" — Return — Vacuum — Combination — Separating; IDEAL BALL FLOAT: VESUVIUS; NASON; THERMAL; TITAN AND TINY BUCKET TRAP.

71
Fulton St.,
NewYork,N.Y.

Steam Specialty Specialists since 1881

NASON STEAM SPECIALTIES: "DETROIT" Receivers; GAUGES—Quick Closing Water—All Iron Liquid Level; FEEDERS—Water—Immersed Valve—Simplex; GLUE HEATERS—Steam—gas; COCKS—Olympus Gauge—All Iron Try.

Think of the TIME You'll Save



with Babbitt Sprocket Rims on all your "high-up" valves. No need of keeping a long, cumbersome ladder always on hand just to close a valve.

Babbitt Rims give you instant and positive control of overhead valves from the floor —save time, steam and accidents. Adjustable to any valve, easily attached and low in cost. Don't delay. Get your Babbitt Rims now! Complete information on request.

BABBITT STEAM SPECIALTY CO.
New Bedford, Mass., U. S. A.

Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

"John Crane" PACKING

We specialize on all packing problems. In the entire range of uses for mechanical packings, there is no combination of conditions involving pressures, temperatures or liquids, that cannot be met economically and with superior service by a type of "John Crane" Packing.

We welcome the opportunity of consulting with you about your packing requirements.

CRANE PACKING COMPANY
1802 Cuyler Ave., Chicago, Illinois

Metallic-Plastic-Fabric

You take no chances

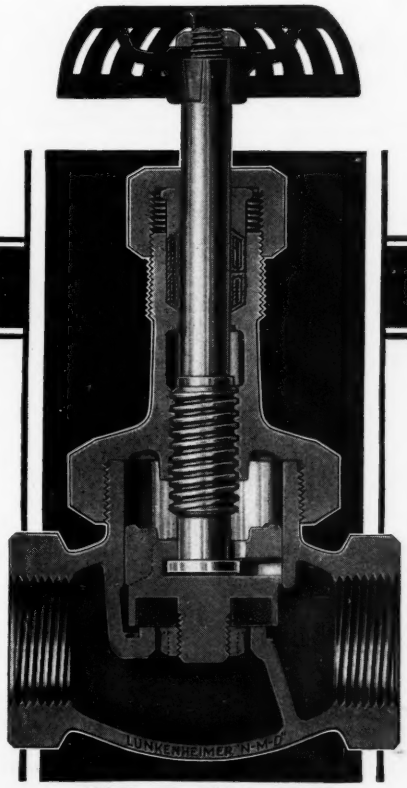
in specifying Hercules Seamless Copper Floats. More than 620,000 in service offer convincing proof of the unfailing, low-cost service they deliver. Guaranteed for working pressures up to 350 lbs. Write us about your float problems.

HERCULES FLOAT WORKS
215 Franklin St., Springfield, Mass.

HERCULES

THE ORIGINAL
SEAMLESS COPPER FLOATS

A Non-Metallic Disc Valve Built to Lunkenheimer Standards



150 lb. SP – 300 lb. GLP

This means a non-metallic disc valve with the inherent quality characteristic of all Lunkenheimer Products. It is your assurance that all parts are manufactured to close tolerances to give the perfect alignment and proper balance so essential in the attainment of satisfactory service.

Fig. 123 "N-M-D"

Note These Features

1. Specially compounded discs for maximum life on steam; hot water; cold water, air and gas.
2. Replacement of the non-metallic disc in disc holder is easily accomplished.
3. Stem thread pitches in all sizes designed to permit tight closure without crushing the disc.
4. Slip-on disc holder. Slightly opening the valve prevents disc holder from dropping off when disassembling the valve.
5. Four guides in disc holder provide an extremely long and wide guiding contact.
6. Sturdy screw-over bonnet provides great strength and facilitates reassembling the valve, as the trimming assembly can be held in one hand and screwed on the body with ease.
7. Extra long pipe threads in body permit a tight joint without danger of pipe ends jamming against diaphragm.
8. Hexagon head gland permits application of a wrench to raise gland without prying.
9. A non-heat handwheel designed to prevent burning the hand. Easy to grip.
10. Every valve individually tested to insure satisfactory performance in service.

Actual performance in your plant is the best proof of service rendered. Place a trial order for "N - M - D" Valves with your Lunkenheimer Distributor and profit from the improved operating efficiency and low-cost service you will obtain.

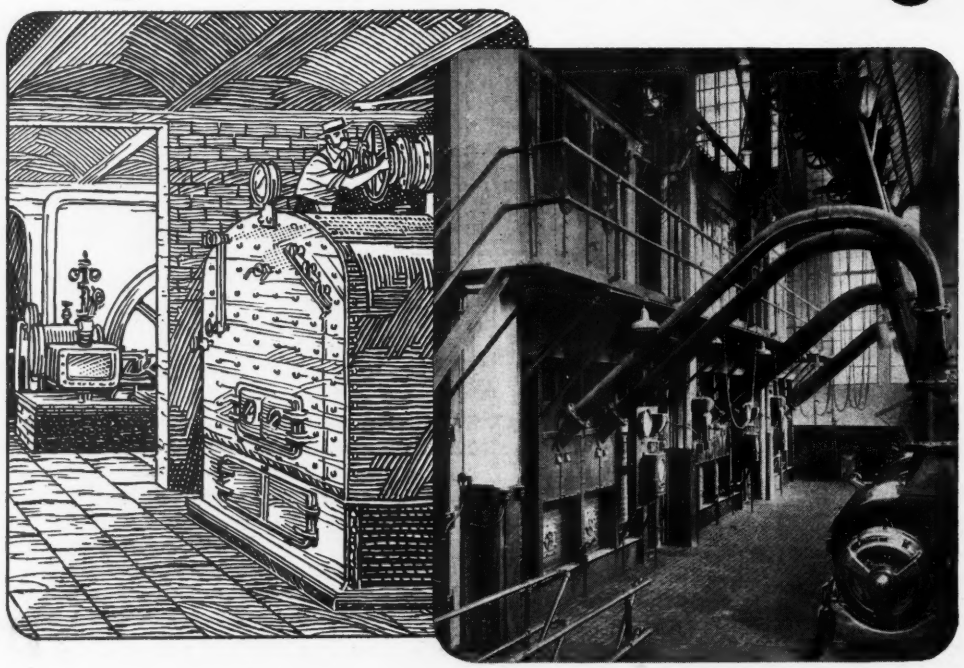
Write for your copy of the "N-M-D" booklet No. 583.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO BOSTON
PHILADELPHIA SAN FRANCISCO
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

VALVES • BOILER MOUNTINGS • LUBRICATING DEVICES

8-8-44

Through Forty Calendar Changes



"We have been using Jenkins Valves for over forty years, and believe that some of these have been in service since our first steam operation"
Albrecht Manufacturing Co.

FORTY years ago! Why, within that time the whole world has changed. Aircraft and submarines, radio and talking pictures, automobiles and motor-ships, refrigeration and air conditioning, streamlined trains and eighty story buildings, were only the vague dreams of visionaries when Albrecht first bought Jenkins Valves.

Yet through these four decades of ceaseless change Jenkins Valves have kept pace with industry's ever changing demands, and have maintained a steadily growing reputation for integrity. Jenkins Valves today, as in the past, are notable for advanced engineering, sound construction, and extraordinarily satisfactory service.

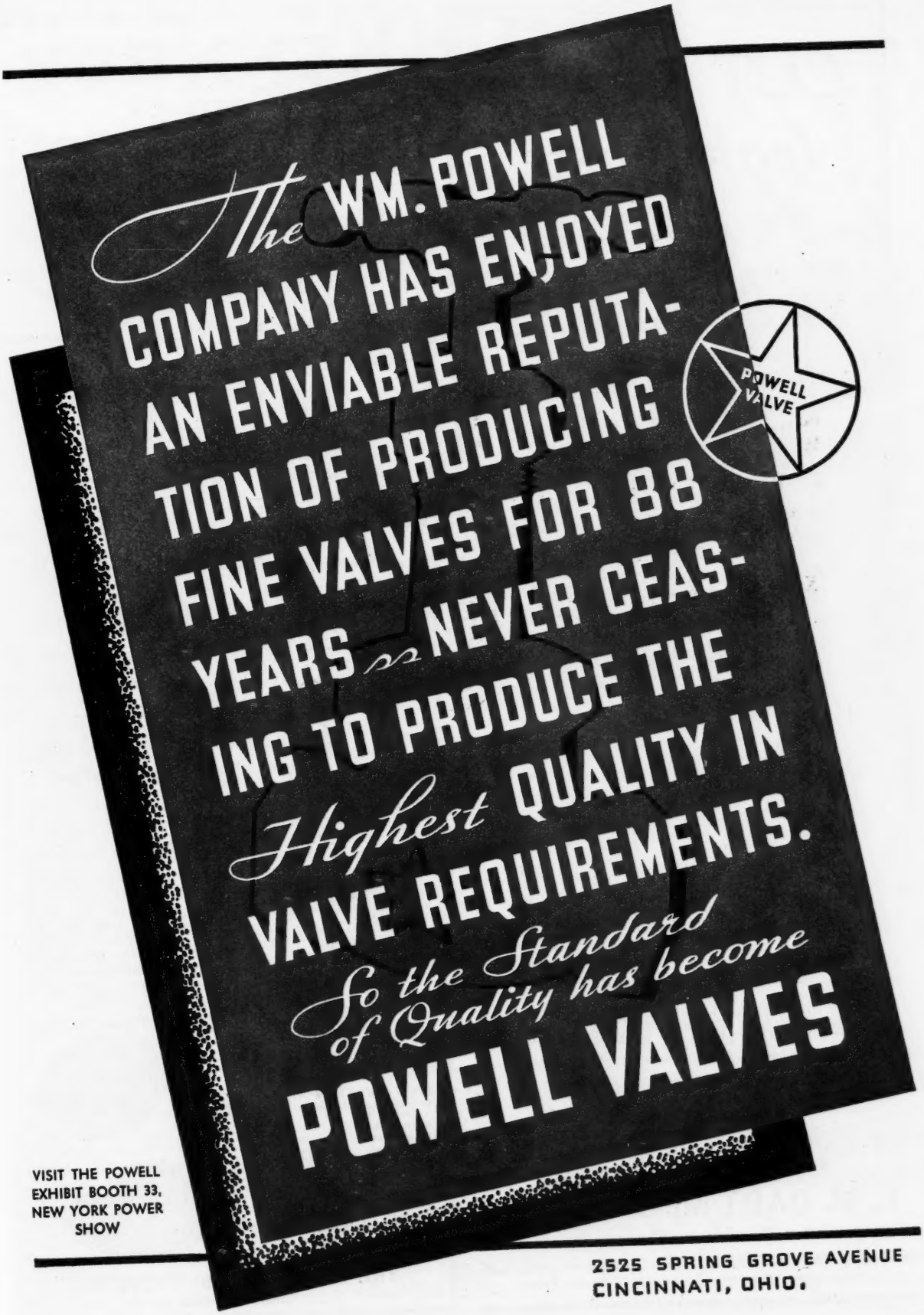
How Jenkins Bros. is paralleling engineering and industrial progress with advanced valve design and new valve types is convincingly portrayed in the new Jenkins Catalog No. 23. In contrast to the comparatively few types and patterns available to the valve buyer forty years ago, this catalog shows approximately five hundred different valves. There is a trustworthy "Jenkins"—of bronze, iron, or steel—to meet the needs of 1935.

Don't Fail To See
"JENKINS ON PARADE"
There's a sight worth seeing and a welcome for you in Booth No. 69—
at the POWER SHOW
Grand Central Palace, New York—Dec. 3rd to 8th

Jenkins Bros

JENKINS BROS., 80 White Street, New York, N.Y.; 510 Main St., Bridgeport, Conn.; 524 Atlantic Avenue, Boston, Mass.; 133 No. Seventh St., Philadelphia, Pa.; 822 Washington Boulevard, Chicago, Ill.; JENKINS BROS., Limited, Montreal, Canada; London, England

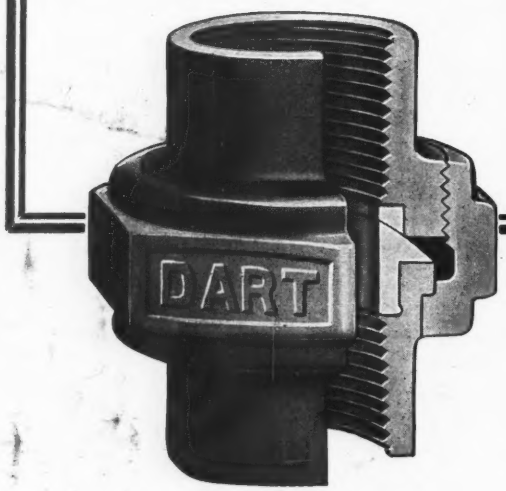
JENKINS VALVES • SINCE 1864 • BRONZE • IRON • STEEL


The WM. POWELL COMPANY HAS ENJOYED AN ENVIABLE REPUTATION OF PRODUCING FINE VALVES FOR 88 YEARS — NEVER CEASING TO PRODUCE THE Highest QUALITY IN VALVE REQUIREMENTS.
So the Standard of Quality has become
POWELL VALVES
POWELL VALVE

VISIT THE POWELL EXHIBIT BOOTH 33, NEW YORK POWER SHOW

2525 SPRING GROVE AVENUE
CINCINNATI, OHIO.

CUT DOWN *leak waste with* DARTS



HIDDEN leaks at pipe joints can waste hundreds of dollars annually in steam, water or other fluids and gases.

Decide now to end these leaks and protect profits by replacing your present unions with Darts, the unions with bronze-to-bronze seats that prevent corrosion and commonly give double the life of ordinary unions.

For more than 35 years Dart Unions have saved money for leading industries of the country—why not in your plant?

Write today for our free Trial Union and catalog describing complete Dart line. No obligation.

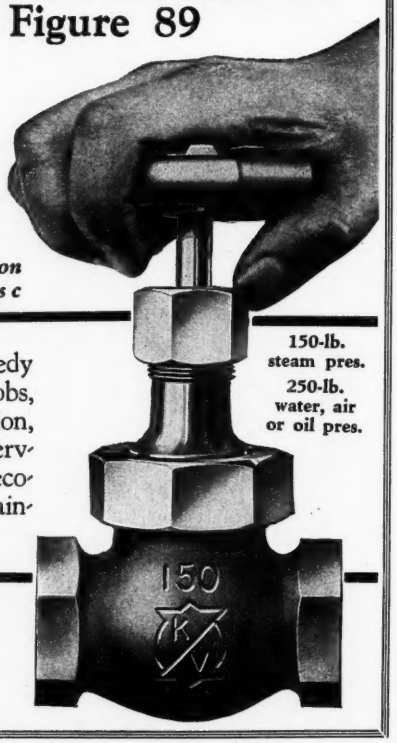
E. M. DART MFG. CO.
Providence, R. I.

Sales Agents: The Fairbanks Company, New York, and at all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

KENNEDY
Figure 89

Heavy Standard Bronze Globe Valve

With Composition Renewable Disc

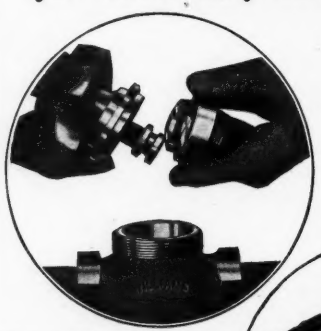


Built for speedy piping jobs, easy operation, long-time service, and economical maintenance.

150-lb. steam pres.
250-lb. water, air or oil pres.

The Kennedy Valve Mfg. Co.,
Elmira, N. Y.

Use VULCODISC
for trouble-free valve jobs



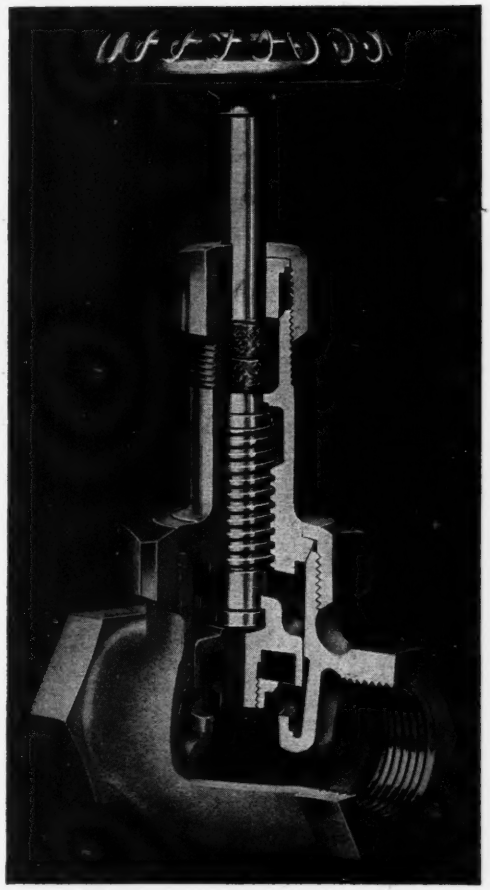
In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften — in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc Holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.
Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

Announcing FAIRBANKS

Improved Globe and Angle VALVES



These improved Fairbanks Bronze Valves are designed to reduce maintenance trouble and expense. They possess many important features such as:

1. The radial seat, between body and bonnet, not only insures a tight joint at this important point but also perfect alignment of all parts. The proper alignment of parts decreases wear; and, when the valve is taken apart for disc replacement, the alignment will be perfect. This seat is drawn to a tight joint by the union nut without sliding or scraping the surface of seat, thereby increasing the life of the valve and assuring a tight body-joint after every assembly.

2. The disc ring not only serves efficiently in the control of steam but also on hot and cold water. It is composed of a very high percentage of long-fibred asbestos, compounded with the necessary vulcanizing elements and given a special cure that produces a most efficient and reliable disc ring.

3. The disc holder is of standard dimensions, permitting the use of other standard makes of disc rings if desired.

4. The stem is of rolled rod bronze, averaging 65,000 pounds tensile strength. More than five clean-cut Acme threads are at all times in contact with the bonnet.

5. The union nut is of heavy bronze with large hexes for a firm wrench grip and permits removal of bonnet with less risk of damage.

6. The protected top seat above the threads on stem gives greater assurance of a clean, tight joint when the valve is fully opened for the purpose of repacking the valve under pressure.

7. The ventilated, malleable-iron handwheel assures a firm, cool grip. The bronze nut holding the wheel is well below the wheel rim surface, thus protecting the hand. This nut is securely held with a lock washer.

Examination of this valve will disclose many other evidences of careful engineering such as the interchangeability of all parts of globe and angle valves, extra large seating surfaces and non-binding disc regardless of position of valves.

Write for copy of our new catalogue or mail the coupon.

See our Exhibit at the Power Show, Booth 73, Grand Central Palace, New York, week Dec. 3rd.

THE FAIRBANKS COMPANY

Manufacturers of Valves, Trucks and Wheelbarrows

399 Lafayette St., New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities

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The Fairbanks Co.,
399 Lafayette St., New York, N. Y.
Without obligation on our part, kindly send a copy of your catalog.

Name .....

Address .....

City..... State.....

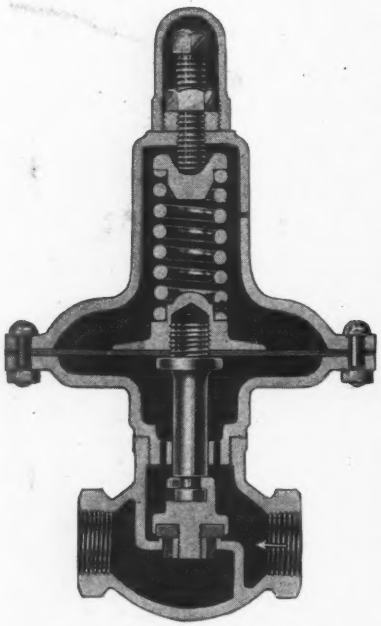
RELIEF VALVES

Exhibited at the New York Power Show

If there is one thing above all others that marks the usefulness of Foster Automatic Relief Valves, it is the sureness with which they go into action when the danger point is reached. They sure are dependable.

Several different types of these valves are available, covering an extremely wide range of pressure conditions. One type, for example, gives precise control on pressures as low as 3 pounds; on the other end of the scale, there is another that gives precise, dependable service on air or fluid pressures up to 4,000 pounds. This type naturally combines with its precision a ruggedness that can stand such severe service.

In the full line of Foster Automatic Relief Valves, there will be one that will meet your pressure relief problem whether it is for steam, water, oil or gas.

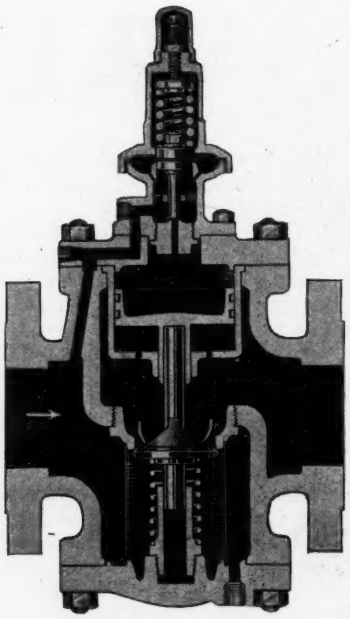


Class S Relief Valve

Diaphragm Actuated

For service on steam, water, oil, ammonia, etc. for pressures up to 130 pounds. Six sizes from ½" to 2".

We invite your inquiry on any problem involving the automatic control of steam, liquids, and gases. Special valves designed and made to meet special problems.



Class G Relief Valve

Pilot Operated

For saturated or superheated steam or for air; pressure range from 20 to 300 pounds. Seventeen sizes from ½" to 12".

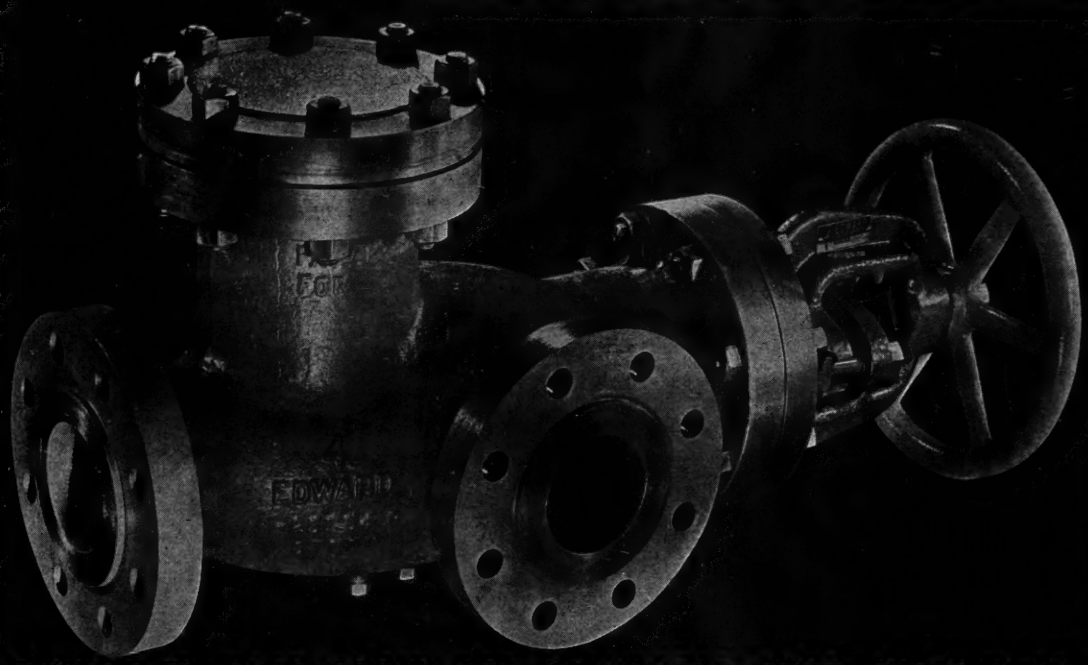
AUTOMATIC VALVES
FOSTER
EST 1879 ENGINEERING CO.

FOSTER ENGINEERING CO.

109 Monroe St., Newark, N. J.

Check EDWARD valves in Power Plants

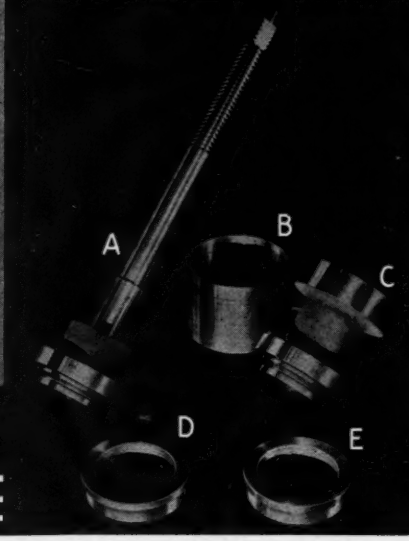
VISIT higher pressure boiler rooms anywhere and check up on the key valves. Odds are you will find Edward valves faithfully functioning in locations where dependable service is imperative



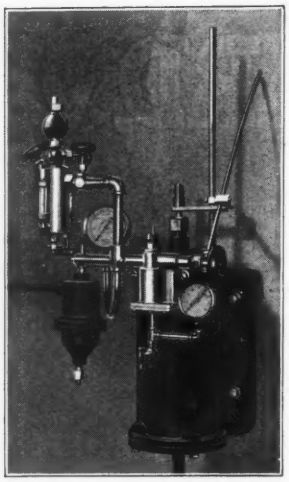
EDWARD Fig. 2850, 600 lb SSP, DRUMHEAD STOP-CHECK VALVE

EDWARD drumhead stop-check valves, for example, are standard equipment almost everywhere. The "separated" type, two valves in a single body, is shown. Assembled at A are the stop valve stem, disk nut and disk, sturdy and durable. B is the alloy steel liner which accurately guides and cushions the movement of C, the check valve piston disk. D and E are the forged erosion-resistant, alloy steel seats.

Ask an Edward representative about the notably dependable, economical service of these valves.



The Edward Valve & Manufacturing Co., Inc.
EAST CHICAGO, INDIANA



The A-JACKS Steam Operated Damper Regulator—note simplicity and quality construction throughout. It is operated at boiler pressure from main header—requires only two simple connections—meets all conditions.

"The little more . . . . . and how much it is!"

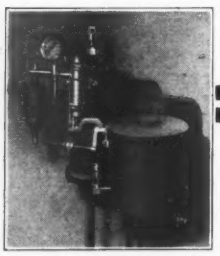
WHAT *is* there about an A-Jacks Control? Perhaps it is that quality that Browning recognized in people and things when he said, "Oh the little more—and how much it is!"

A little more precision in manufacture—a little more quality of materials—a little more care in the design and construction—these are the plus qualities that explain the ability of A-Jacks Controls to give flawless performance year after year, without the usual need for adjustment or repairs.

Among the many unduplicated features of A-Jacks Steam Operated Damper Regulators are the simple, positive adjustment to any boiler pressure, and the adjustable compensator which permits any desired variation of damper action.

Utilizing the same basic principles, the A-Jacks Over-Fire Control gives the same sensitive and graduated damper action from over-fire pressure. When used to control the damper in combination with the A-Jacks Regulator (independently controlling stoker and blower speeds) the result is a combustion control of the most efficient type that will pay for itself many times over in fuel saved.

Ask for the new A-Jacks catalog. It clearly illustrates the many features of A-Jacks Controls.



A-JACKS Over-Fire Control. Employs the same time-tested basic principles that are used in the A-JACKS Regulator.

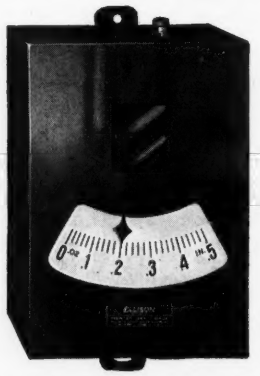
NATIONAL REGULATOR CO.
2301 Knox Avenue, Chicago, Ill.
Representatives in Principal Cities

A-JACKS CONTROL

For High Pressure Boilers

How to Fire By the Draft Gage

Range .25" Scale 5"
$23.00
Surface Mounting



Range .5" Scale 5"
$22.50
Surface Mounting

Ellison Pointer Draft Gage —Dial Type

THIS 1-pointer gage is for the furnace draft of any size boiler burning any kind of fuel, hand or stoker fired, where only the furnace draft is to be indicated. For all low drafts not exceeding .25", use the .25" range, multiplying 20 times. For higher drafts use the .5", multiplying 10 times. Carry the thickest fuel bed that will burn the fuel properly and the lowest natural furnace draft that will carry the load. A fall in the draft reading at same damper setting indicates thinner fuel bed or holes in the fire—excess air and fuel waste. A rise in the draft reading indicates thicker fuel bed or clinkers, a drop in the steam pressure. For midwestern coal, natural draft, the furnace draft in hand fired furnaces under normal load range is from about .20 to .40", and in chain grate stokers from about .15 to .30". Unless air sealed, keep a banked fire against the water-back of this stoker. Check your combustion efficiency with the new Ellison Portable Gas Analyzer.

Next Lesson Down Draft Furnaces.

Ellison Draft Gage Company
214 West Kinzie Street Chicago

One Tachometer for ALL Your Speeds

Six Ranges

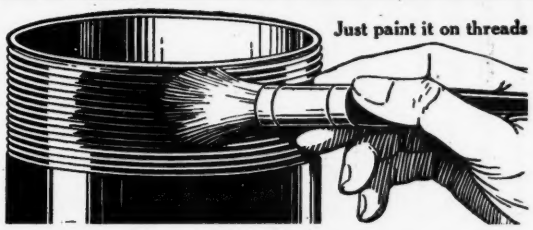
25 to 30,000 R.P.M.

The new Foxboro-Horn Multi-Range Hand Tachometer gives accurate readings of speed **directly in R.P.M.** Fits snugly in the hand—weight 23 oz. — dial 2⅝" — changes of speed made rapidly and with ease. Furnished in neat compact carrying case.

FOXBORO
REG. U. S. PAT. OFF.
THE COMPASS OF INDUSTRY

Write for Folder 601

THE FOXBORO COMPANY, Foxboro, Mass., U. S. A.
Complete Industrial Instrumentation



For making threaded pipe joints that will never leak

BECAUSE its soft metallic body is permanently impassable to any fluid under any working pressure and any temperature, SMOOTH-ON No. 3 will hold perfectly.

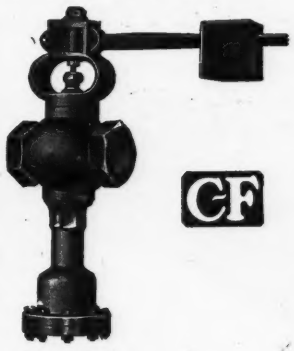
Smooth-On No. 3 adheres well to the threads, expands and contracts with the pipe, and fills every minute void with a deposit which can't blow out, shrivel, shrink, or crack from time or heat. Joints sealed with this metallic filler are not affected by vibration or violent change of temperature or pressure, yet may be taken apart at will.

Smooth-On No. 3 is packed in 1-lb. and 5-lb. cans and larger kegs. Buy from your supply house or from us.
Write for the Smooth-On Handbook

SMOOTH-ON MFG. CO., Dept. 31
570 Communipaw Ave., Jersey City, N. J.

Do it with SMOOTH-ON

Keep Excess Pressure CONSTANT *On Your Feed Lines*



Piston Type Boiler-Feed Pump Governor

EFFICIENCY and economy demand that the excess of feed-line pressure over boiler pressure shall be constant. It will be if you install a C-F Boiler-Feed Pump Governor. When steam pressure rises, the pump is automatically speeded up. When steam pressure falls, the pump is automatically slowed down. Two types of governor are offered, one activated by diaphragm, the other by piston. With either type, action is positive and regulation perfect. Ask for special bulletin; also information on VIGILANT Feed Water Regulator and other Steam Specialties. Catalog on request.

The Chaplin-Fulton Manufacturing Co.
28-40 Penn Avenue **Pittsburgh, Pa.**

Can you use

More Money?

We need a practical Engineer for Field Work. Our men earn up to

$100.00 per week

Applicant must have thoro knowledge of Boiler Practice. No other experience necessary. If you are not satisfied with your present income, write today, giving experience and references. Box 1218, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

YOUR BOILERS NEED • • SOFT WATER • •

WE MANUFACTURE ALL SIZES AND TYPES OF WATER SOFTENERS & FILTERS

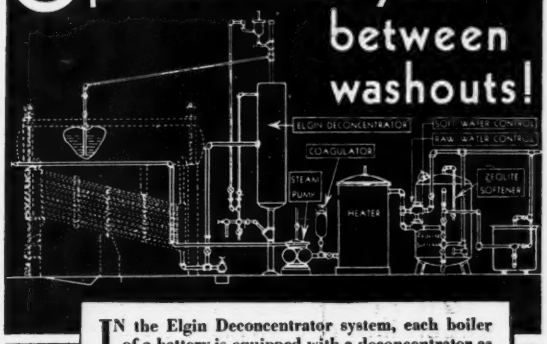
Cold Process: Intermittent, Continuous and Zeolite. Hot Process, Semi-Hot Process and specially designed Water Softeners.

Gravity, Pressure and Oil Removal Filters.

WRITE FOR INFORMATION AND BULLETINS.

WM. B. SCAIFE & SONS CO.
OAKMONT, PA.
NEW YORK **PITTSBURGH** **CHICAGO**

Operate a full year between washouts!



IN the Elgin Deconcentrator system, each boiler of a battery is equipped with a deconcentrator as shown above. A definite portion of the boiler water circulates through this settling tank. Suspended matter and sludge settle to the bottom of the tank and the clarified water returns to the boiler. The accumulated sludge is removed periodically by opening a drain line.

With the deconcentrator, the boiler is kept absolutely clean. It is not unusual to operate a boiler equipped with an Elgin Deconcentrator for more than a year without cleaning.

Write for complete information.

Elgin ELGIN SOFTENER CORP.
57 NORTH STREET ELGIN, ILL.

BOILER WATER CONDITIONING

LOW *Heads* • HIGH *Speeds*

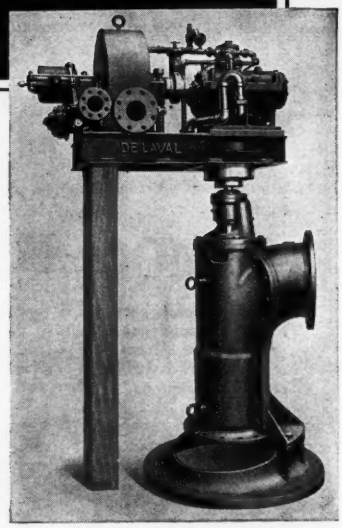
The DE LAVAL PROPELLER PUMP

• De Laval propeller pumps running at standard steam turbine and electric motor speeds deliver any volume against heads up to 40 ft., with efficiencies comparable to those of centrifugal pumps of the same power.

They reduce the cost of piping and save floor space. With the propeller set below low water, no priming system is required.

The steep head-capacity characteristic permits of operating two or more pumps in parallel. This makes possible a considerable saving of power, as one of the pumps can be shut down at reduced loads. The delivery of a single pump is well maintained in spite of wide variations in head pumped against.

The power limiting characteristic protects the motor against overload. *Described in Catalog B-6.*



●ABOVE—Propeller pump driven by steam turbine through De Laval worm gear.

● TOP RIGHT—Propeller pump driven by directly connected steam turbine.

●TOP LEFT—Parts subject to wear, namely: propeller, case protecting sleeve and bearings, are renewable.

De Laval *Steam Turbine Co.*, Trenton, N.J.

3167

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps, Centrifugal Blowers and Compressors, Worm Gears, Helical Speed Reducing Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery. Sole Licensee of the Bauer-Wach Exhaust Turbine System.

THEY *Checked* PUMPING COSTS

AND SAVED $8,000

A Pennsylvania company replaced several other makes of pumps requiring a total of 375 H. P. with two Warren Centrifugal Pumps; one 100 H. P. and one 50 H. P. These two new pumps are handling the same load . . . *and saving approximately $21 a day—$8,000 per year—in power alone.*

This pumping job is a strenuous, seven-day-a-week grind—but these two Warrens are thriving on the punishment and putting money in the bank. For these Warren Pumps were built to fit the job by engineers who constantly study power plants, paper mills, coal mines, every type of American Industry—developing Warren Pumps that will provide the lowest possible pumping cost per year.

Don't take your pump operating and maintenance costs for granted . . . give your pump records the third degree. They may talk, and tell which of your pumps might profitably be replaced with efficient Warren Pumps, engineered to fit the job. A Warren Engineer will be glad to check your pumping requirements with you. His recommendations may enable you to make substantial reductions in your operating costs.

WARREN STEAM PUMP CO., INC.

WARREN, MASSACHUSETTS

QUIET and Efficient

A great combination — this Buffalo "Limit-Load" Conoidal Fan — (by Audiometer Test quieter than others, — highly efficient, — smooth as silk in operation), mounted on a Buffalo Silent Floating Base, which "dampens out" motor vibrations ordinarily transmitted to the building.

Because we know of no other fan equipment so suitable for installations where quiet operation is important — we unhesitatingly recommend this outfit for any job. Write us for details and full specifications.

Buffalo Forge Company

188 Mortimer St., Buffalo, N. Y.

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" Limit Load Conoidal Fans with SILENT Floating Base

For More Efficient Spray Distribution

ALMOST any type of spray nozzle will increase the efficiency of a cooling system not already so equipped.

Marley patented spray nozzles provide the maximum of improvement because they are free from clogging, provide a finer, more uniform spray and operate efficiently under low pressures.

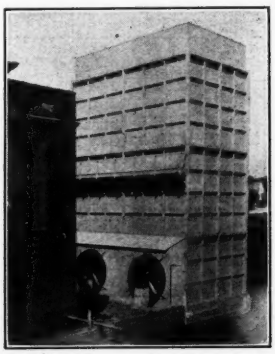
Marley nozzles cost no more—and lead the field in sales. Write for complete information.

THE MARLEY COMPANY
1915 Walnut Kansas City, Mo.

MARLEY
PATENTED SPRAY NOZZLES

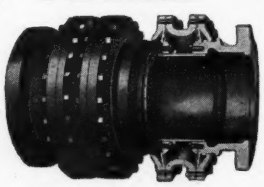
SAVE PUMPING COSTS!

The low pumping head, characteristic of the Schubert-Christy gravity splash distribution system, is saving thousands of dollars every month for the users of these highly efficient cooling towers. Day in and day out this saving goes on—and actually pays for the tower. Ask us about this one of the many Schubert-Christy advantages.



Schubert-Christy Corp.
Box 2477 Affton, Mo.

ADSCO Expansion Joints



ADSCO Multiple Diaphragm Variator.

ADSCO Variators are packless expansion joints designed for trouble-free service and long life. Basic principle in use more than forty years.

Write for Bulletin.

AMERICAN DISTRICT STEAM COMPANY
GENERAL OFFICES AND WORKS
NORTH TONAWANDA, N.Y.
OVER FIFTY YEARS IN BUSINESS

CHRONILLOY

A NEW ALLOY FOR HIGH TEMPERATURE ELEMENTS—GUARANTEED

BAYER-CHRONILLOY for special high temperature elements in the hottest zones is what power plant operators have been waiting for.

The development of this special BAYER-CHRONILLOY element is an important advance in soot cleaner practice.

The elements are made in two grades, containing from 40% to 80% combined chromium and nickel content, with other elements added to give the special and superior qualities so vitally necessary for soot cleaner elements. In addition to superior heat resisting properties, the alloy is strong and tough and has the necessary rigidity to resist warping. Moreover, the wall of the element is some 20% thicker than the walls of extra heavy seamless alloy tubing commonly used.

ADVANTAGES

BAYER-CHRONILLOY, unlike the straight chromium alloys, has practically no grain growth and does NOT become brittle—it is highly resistant to shock at elevated temperatures so that it does not crack and ends do not blow out.

HEAVY WALL to resist warping

NOZZLES—The nozzles are formed integral with the element wall, therefore nozzles cannot become loose and blow out.

GUARANTEE

ALL BAYER-CHRONILLOY elements are sold with a special unqualified guarantee against burning out for a period of 18 months, and the Bayer Company will replace f.o.b. St Louis, any such element which has so failed in service.

Such a guarantee really protects you. You are invited to take advantage of it.

Our engineers are at your service.

THE BAYER COMPANY

1506 S. GRAND BLVD. ST. LOUIS, MO.

Johns-Manville

FIRECRETE

A NEW KIND OF REFRACTORY CONCRETE

Standard Firecrete 2400° F.

H.T. Firecrete 2800° F.

Write for BROCHURE-RC-6A

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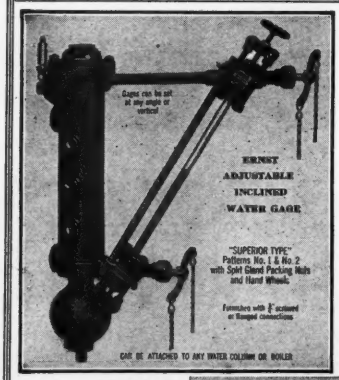

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SPLIT-GLAND ADJUSTABLE WATER GAGES WITH ROUND TUBULAR GLASSES

FOR ANY PRESSURE UP TO 1000 POUNDS

Also: ERNST

WATER COLUMNS with or without Alarms

LEAKLESS COCKS

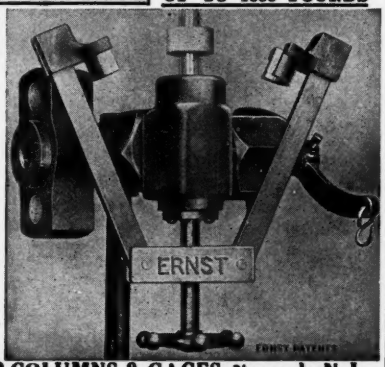
High Pressure

Gage Glass Gaskets that will fit— and give service—

GAGE GLASSES

"CLEAR", or with magnifying "RED LINE"

Ask for Catalog "B"



ERNST WATER COLUMNS & GAGES—Newark, N.J.

New York: W. K. Sowdon Co. Los Angeles: Guy L. Warden

Pittsburgh: G. C. Donaldson

Philadelphia: Fenno-Fischer Co. Syracuse, N. Y.: Cross-Glave Co.

Austin, Tex.: Theo. Langenbergh San Juan, P. R.: Enrique Abarca

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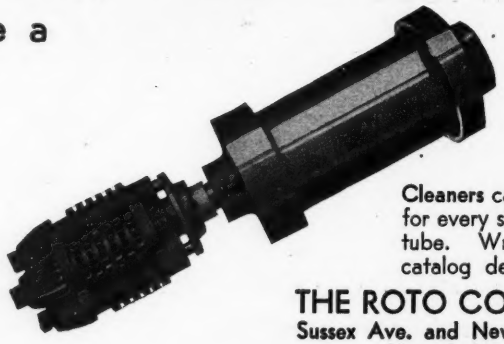
Get Cheaper Steam — Use a

ROTO

TUBE CLEANER

Frequent tube cleaning with a ROTO will help your boilers, economizers and heaters do better work and produce steam at notably lower cost. . . . . You'll find a ROTO does the job quickly and thoroughly —requires much less cleaning time. . . .



ROTO Tube Cleaners can be furnished for every size and type of tube. Write today for catalog describing them.

THE ROTO COMPANY

Sussex Ave. and Newark Street

Newark, N. J.

Lonergan

Pressure Gauge Model "BOE"

Since 1872 "The Lonergan Line"

Pressure Gauge, Model "BOE", strong, accurate, well built, is a worthy member of "The Lonergan Line" of appliances which have been protecting steam, hydraulic, gas oil, air and ammonia installations since 1872.

Wherever you are, there is a Lonergan engineer near you. His knowledge is at your disposal without obligation. Write to us.

J. E. LONERGAN CO.

217 Race Street Philadelphia, Pa.

Ask for Catalogue of "The Lonergan Line"

300 specialties for power plants

A Dean Will Last Longer

—cost less, and do a more thorough job of scale *and* hard soot removal than any boiler tube cleaner on the market. Write for the facts today!

THE WILLIAM B. PIERCE COMPANY

149 Ellicott Street Buffalo, N. Y.

Dean

REG. U.S. PAT. OFF.

TUBE CLEANERS

(For all types of boilers)

A man with a trowel and EAGLE "66"

STOPS HEAT WASTE

Here is why you will profit from using EAGLE "66" PLASTIC INSULATION:

Use EAGLE "66" PLASTIC INSULATION

First—You want insulating efficiency, and Eagle "66" is extremely efficient up to 1800° F.

Second—It goes on quickly and easily. A man with a trowel and Eagle "66" does the job in a hurry. No special tools needed. This plastic insulation goes on easily around corners and over irregular surfaces.

Third—Eagle "66" Plastic Insulation sticks to hot surfaces like glue, forming a strong, efficient one-piece insulation. No joints or seams to open up and let out the heat.

Fourth—Eagle "66" is 100% reclaimable. Alterations, changes, repairs are easy and inexpensive to make.

Fifth—Eagle "66" has 25% to 75% greater coverage than other plastic insulating materials—50 square feet 1″ thick per 100 lb.

• Before you do another insulating job, get a free sample and all the facts about Eagle "66" Plastic Insulation. The coupon is for your convenience.

THE EAGLE-PICHER LEAD COMPANY

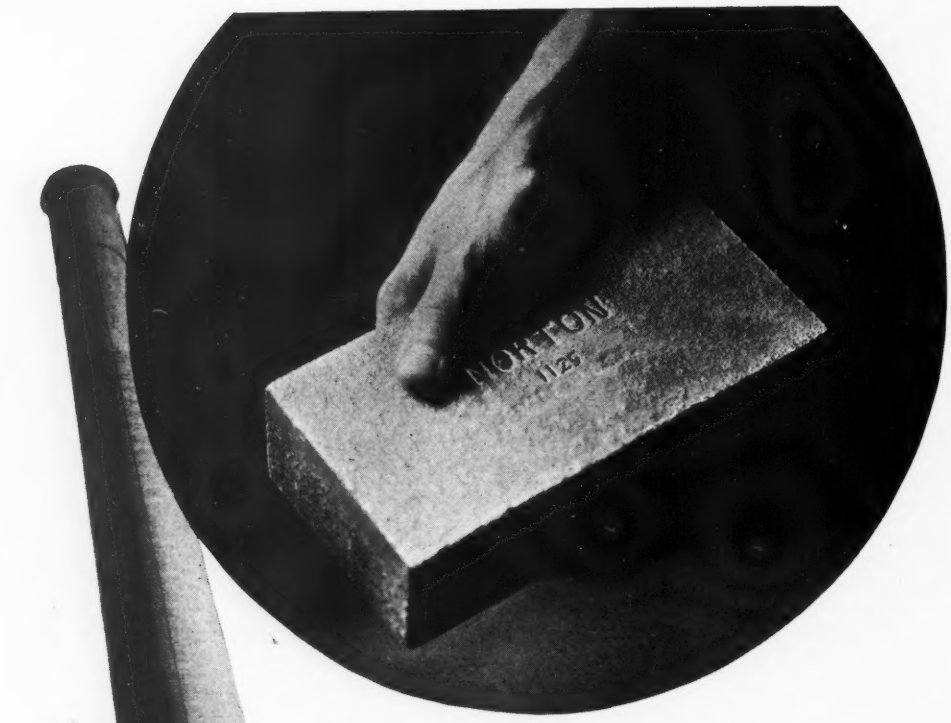
Manufacturers of a full line of industrial insulating materials for a complete range of temperatures. Branch Offices and Stocks in Principal Cities.

• The Eagle-Picher Lead Company, Dept. PPE12 Cincinnati, Ohio.
Please send free sample and descriptive catalog of Eagle "66" Plastic Insulation.

Name_____

Address_____

City_____ State_____



Just Try This CRYSTOLON BRICK

You'll Like the Way It Cuts Boiler Lining Costs

YOU'LL find this Crystolon Brick different from any other heavy duty brick that you have tried—even different from previous Norton brick.

There are two good reasons why it is different—why this Crystolon Brick is showing definitely longer life in boiler furnaces everywhere. One is its composition—as it comes from the kiln it contains over 90% of silicon carbide. The other is the new method of manufacture—known as the Controlled Structure process and first developed for Norton Grinding Wheels.

Try this Crystolon Brick. See in your own boilers how these two features enable the brick to show real savings.

NORTON COMPANY, WORCESTER, MASS.

NORTON REFRACTORIES

R-493

CRYSTOLON [SILICON CARBIDE] BRICK

3 CONTRACTS FOR DETROIT STOKERS

COMPLETE SATISFACTION

THIS third contract from Theodore Hamm Brewing Company consists of three Detroit Multiple Retort Stokers to serve three 4750 sq. ft. steam generating units—300 lbs. pressure—150 degrees superheat. They are designed to operate at 250% capacity with preheated air at 300 degrees. Three contracts from this prominent brewery is certainly conclusive proof of the operating economy and dependability of Detroit Stokers.

Detroit Multiple Retort Stoker construction embodies an inclined fuel bed, the slope of which permits an effective under-feed action and continuous movement of the fuel to the rear under complete mechanical control. Correct air distribution to the entire fuel bed is obtained by the air zoning method. These characteristics, now recognized by engineers as a marked improvement, have been largely responsible for the increasing popularity of Detroit Multiple Retort Stokers. Write for bulletin 124

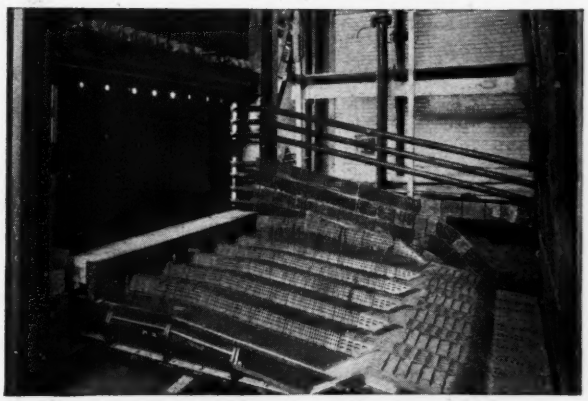
DETROIT STOKER COMPANY

Sales Offices and Engineering Department:
Fifth Floor, General Motors Building, Detroit, Michigan
Works at Monroe, Mich.—District Offices in Principal Cities

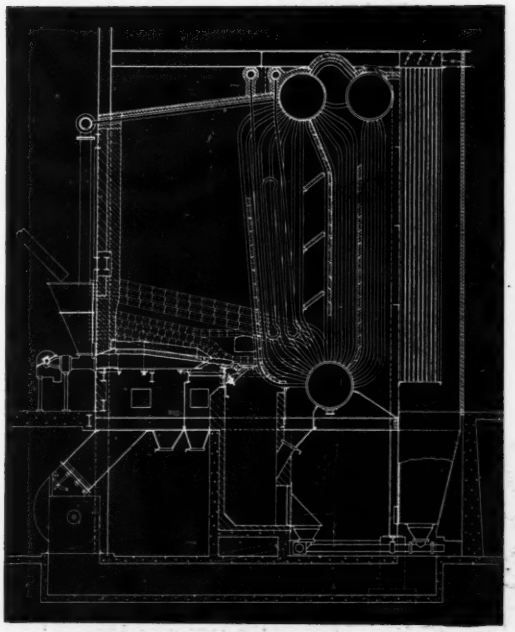
DETROIT STOKER COMPANY OF CANADA, LIMITED
WINDSOR, ONTARIO
Built at London, Ontario

THEODORE HAMM BREWING COMPANY

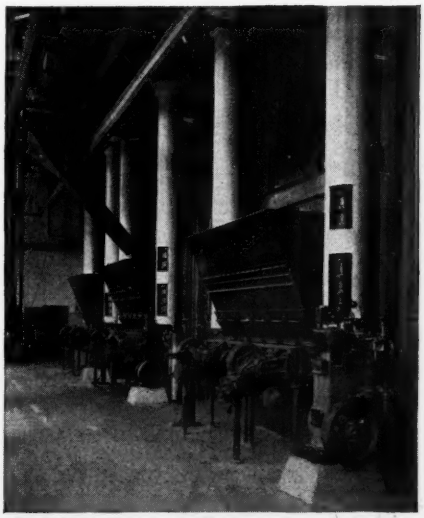
ST. PAUL, MINN.



One of the Detroit Stokers for Theodore Hamm Brewing Co. during erection.



Application of Detroit Multiple Retort Stokers to the 475 H. P. steam generating units.



An interior view of the new power plant of the Theodore Hamm Brewing Co., St. Paul, Minn.

MODERNIZE AND ECONOMIZE WITH

DETROIT

SINCE 1898

STOKERS

Steam Costs Reduced at Fort Howard

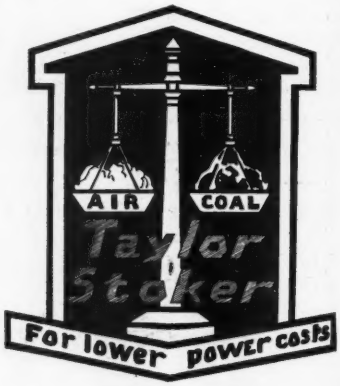
To provide increased and more economical steam generating capacity, the Fort Howard Paper Company, Green Bay, Wisc., recently installed a bent tube boiler designed for an output of 100,000 lb. of steam per hour at 425 lb. pressure and at a total temperature of 600 deg. F.

This boiler is fired by a modern Straight-Line Drive **Taylor Stoker** with Rotary Ash Discharge and a Hele-Shaw Drive. The Hele-Shaw Drive varies the coal feed over an extremely wide range and is operated by an automatic combustion control to suit plant load requirements.

An engineer's report says: "The constant 24-hour demand for steam and power for paper making operations gives us little time to shut down boilers and clean fires. The **Taylor Stoker** has enabled us to exceed the guaranteed boiler efficiency, permits us to keep the boiler running for longer periods at full load and has enabled us to *reduce the cost of steam 18 per cent.*"

The price you pay for power service is going to have an important bearing on the profits your company makes in 1935 and following years. Material prices are up. Labor rates are up. Power service costs—the third major factor in determining manufacturing expense—can and are being forced down in many progressive plants through the use of modern **Taylor Stokers.**

Let us discuss with you the possible ways of getting more steam out of your boilers, burning cheaper coal, lowering power service costs in your plant. A "Combustion Audit" by our engineers costs you nothing. It may increase your operating profits many thousands of dollars annually. Write us about it.



AMERICAN

AMERICAN ENGINEERING COMPANY, ARAMINGO AVENUE, PHILADELPHIA, PA.

18 per cent Paper Company

NEW Straight-Line Drive Taylor Stoker, with Hele-Shaw Drive to vary rate of coal feed, which helped reduce the cost of steam 18 per cent at plant of Fort Howard Paper Co., Green Bay, Wisc. W. L. Fergus, Consulting Engineer

ENGINEERING

IN CANADA: AFFILIATED ENGINEERING COMPANIES, LTD., MONTREAL, P. Q.

THE BIRTH OF TIMKEN BOILER TUBE SAFETY AND LONG LIFE

Batteries of electric furnaces to produce boiler tube alloy steel that possesses maximum creep resistance at sustained high temperatures, with ample reserve strength for any emergency... rigid chemical and metallurgical inspection to assure uniform quality... slow, careful rolling to produce tube blanks that are accurate in size and section and free from internal and surface defects... piercing equipment that assures tubes that are concentric and uniform in wall thickness to an extremely high degree. The combined result—PERFORMANCE that is setting new standards of endurance and economy in boilers, superheaters and heat exchangers. PERFORMANCE that is influencing more and more power plant operators to specify Timken Boiler Tubes. Timken metallurgical engineers will be glad to study your operating conditions with a view to recommending the type of Timken Tubes that will give the best results.

THE TIMKEN STEEL & TUBE COMPANY, CANTON, OHIO

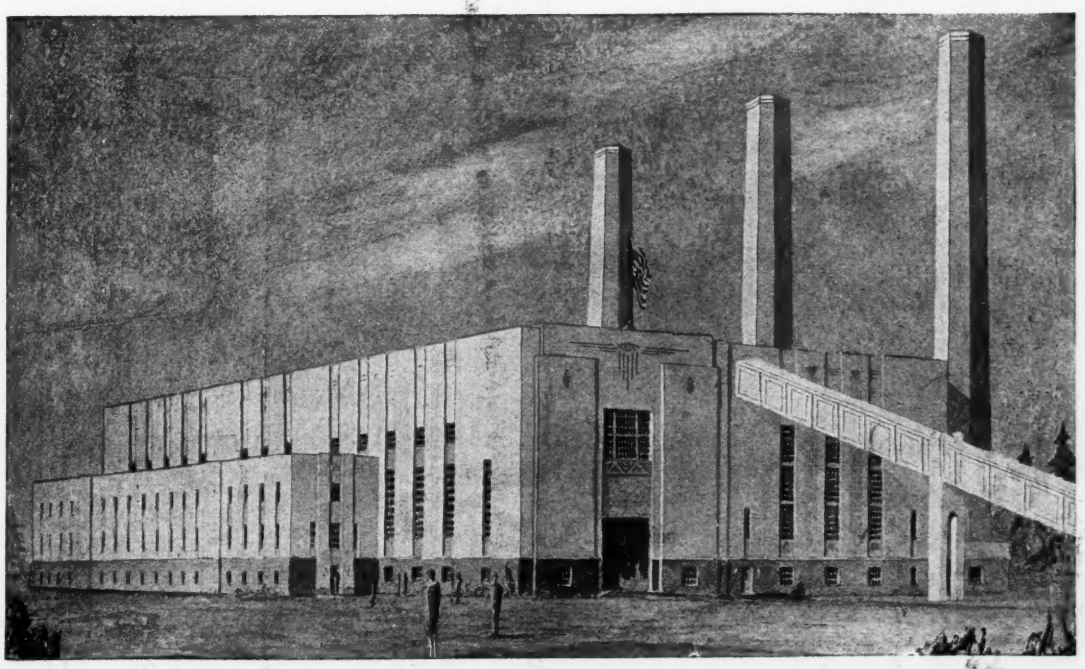
District Offices or Representation in the following cities: Detroit Chicago New York Los Angeles Boston Philadelphia Houston Buffalo Rochester Syracuse Tulsa Cleveland Erie

World's Largest Producer of Electric Furnace Steel

TIMKEN STEEL TUBES

ELECTRIC FURNACE AND OPEN HEARTH • ALL STANDARD AND SPECIAL ANALYSES

A MODERN OUTSTANDING CENTRAL STATION USING THE KENNEDY PULVERIZED FUEL SYSTEM ONE OF THE MOST EFFICIENT PLANTS IN THE WORLD



THE EDGEWATER GENERATING STATION of the WISCONSIN POWER and LIGHT CO.
Kennedy Van-Saun Mfg. and Engineering Corp., 2 Park Ave., New York, N. Y.

WICKES BOILERS
Horizontal Cross Drum Boilers
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THE WICKES BOILER CO
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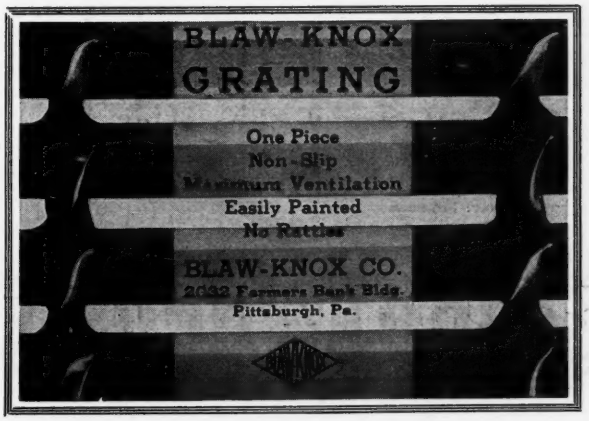
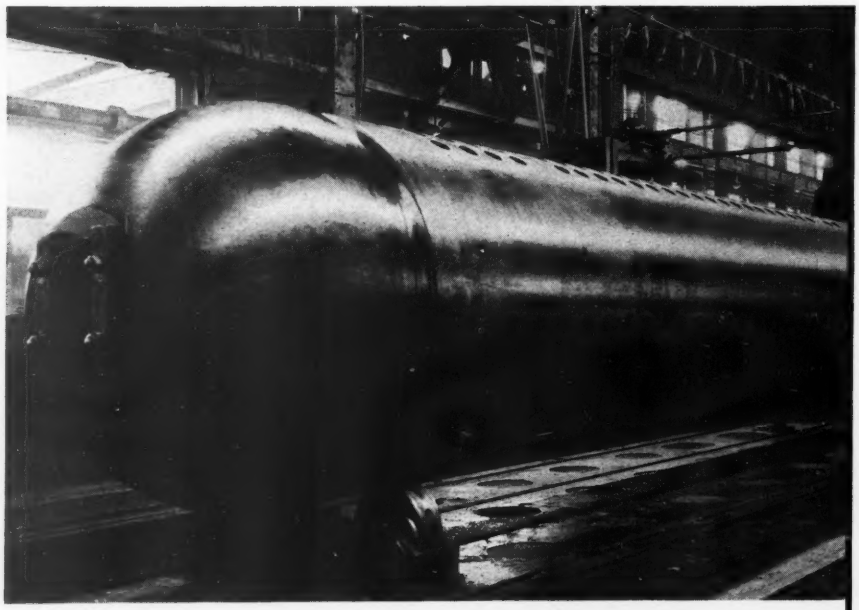
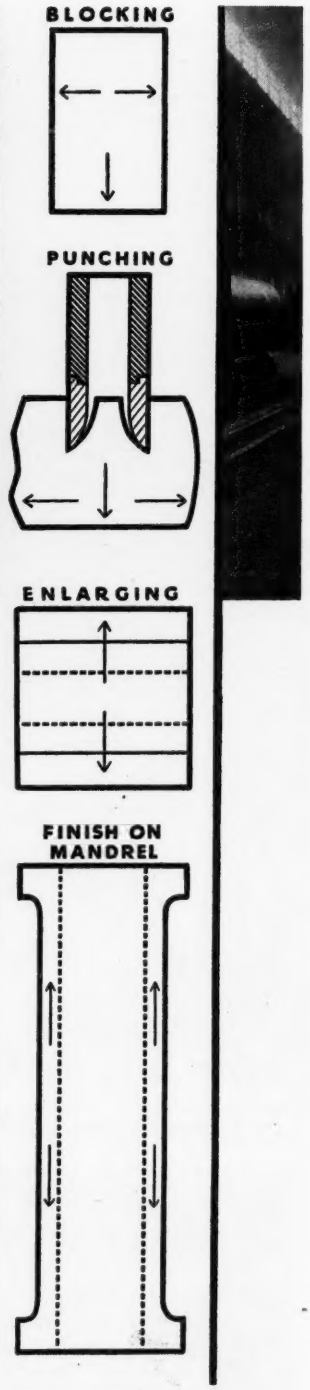


GRAVER
SPECIAL STEEL FABRICATION
INSTALLATION
TANKS
WATER CONDITIONING EQUIPMENT
The Graver Organization has unexcelled facilities for manufacturing and fabricating tanks and plate of steel, nickel clad or stainless steel, aluminum and other alloys. Our engineering department will design equipment completely to your needs or build to specifications. Production costs are low. Our field erection is recognized for good workmanship. Our experience and responsibility are long standing. In addition, Graver makes water conditioning equipment, gas holders and accessory tanks and B. F. Goodrich Vulcalock Rubber Lined Steel Tanks.
Graver Tank & Mfg. Corp.
General Sales Office: 332 South Michigan Avenue, Chicago.
General Offices and Factory: East Chicago, Indiana.
New York Tulsa
SEVENTY FIVE YEARS OF SERVICE TO INDUSTRY

Fine Steel with no seams





-the last word in safety

BETHLEHEM Forged Seamless Boiler Drums are made by a process that, in addition to eliminating seams, is recognized as turning out steel of unusual quality.

In making one of these drums the center is punched out of an ingot, and the ingot forged into a cylinder. The drum consists of one piece of homogeneous, thoroughly-worked steel, entirely free from seams or joints.

The strength of a Bethlehem Forged Boiler Drum is the strength of the steel itself. Bethlehem can make these completely dependable boiler drums to any dimensions.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

BETHLEHEM STEEL

District Offices: Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Kansas City, Milwaukee, New York, Philadelphia, Pittsburgh, St. Louis, St. Paul, Washington, Wilkes-Barre, York. *Pacific Coast Distributor:* Pacific Coast Steel Corporation, San Francisco, Seattle, Los Angeles, Portland, Honolulu. *Export Distributor:* Bethlehem Steel Export Corporation, New York.

BETHLEHEM FORGED SEAMLESS BOILER DRUMS

A PROFITABLE INVESTMENT... PROVED BY

simple arithmetic

ITEMS INVOLVED IN COST	WITH FIRECLAY BRICK	WITH B&W 80 FIREBRICK
Initial cost of refractory, delivered and installed	$1,100.00	$3,200.00
Life of lining	3 months	24 months
Cost of replacing sections failing, labor and material	$625.00	0
Number of replacements required in two years	7	0
Total cost of replacements in two years	$4,375.00	0
Total expenditure in two years	$5,475.00	$3,200.00
Saving secured by B&W 80 Firebrick	$2,275.00	

THIS ESTIMATE IS BASED ON ACTUAL SERVICE RECORDS OF TWO FIVE-HUNDRED HORSEPOWER SLUDGE-FIRED BOILER FURNACES

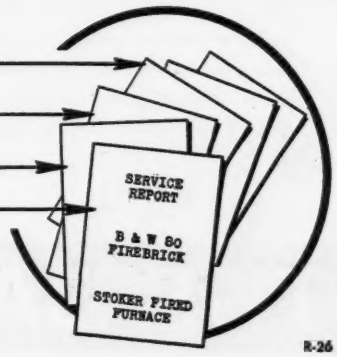
Expensive? Simple arithmetic proves that B&W 80 Firebrick cost less than the cheapest fireclay brick! True, this cost is based on two years' service ... but when you rebuild your furnaces, won't you expect them to last two years?

They may not if you use fireclay brick and your service conditions are extreme. Then an installation of B&W 80 Firebrick will be a profitable investment ... they have lasted five to fifty times as long as fireclay brick, and have effected savings of five hundred to five thousand dollars a year.

Savings similar to these may be secured, even if your conditions are less severe. At a delivered-and-installed cost but slightly higher than that of fireclay brick, it is decidedly profitable to use the B&W Junior ... a companion firebrick exceeded only by the 80 in characteristics requisite to long life.

You do not need a salesman to tell you whether your firebrick replacements are frequent and costly ... nor do you need one to find out if B&W 80 or Junior Firebrick will save money for you. Simply write for Service Reports on the types of furnaces you operate ... they will indicate the adaptability of these firebrick to your conditions. No obligation, no cost, and no annoying sales solicitations. A penny postcard will do ... addressed to The Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

OIL-FIRED FURNACES
PULVERIZED-COAL-FIRED FURNACES
GAS-FIRED FURNACES
STOKER-FIRED FURNACES



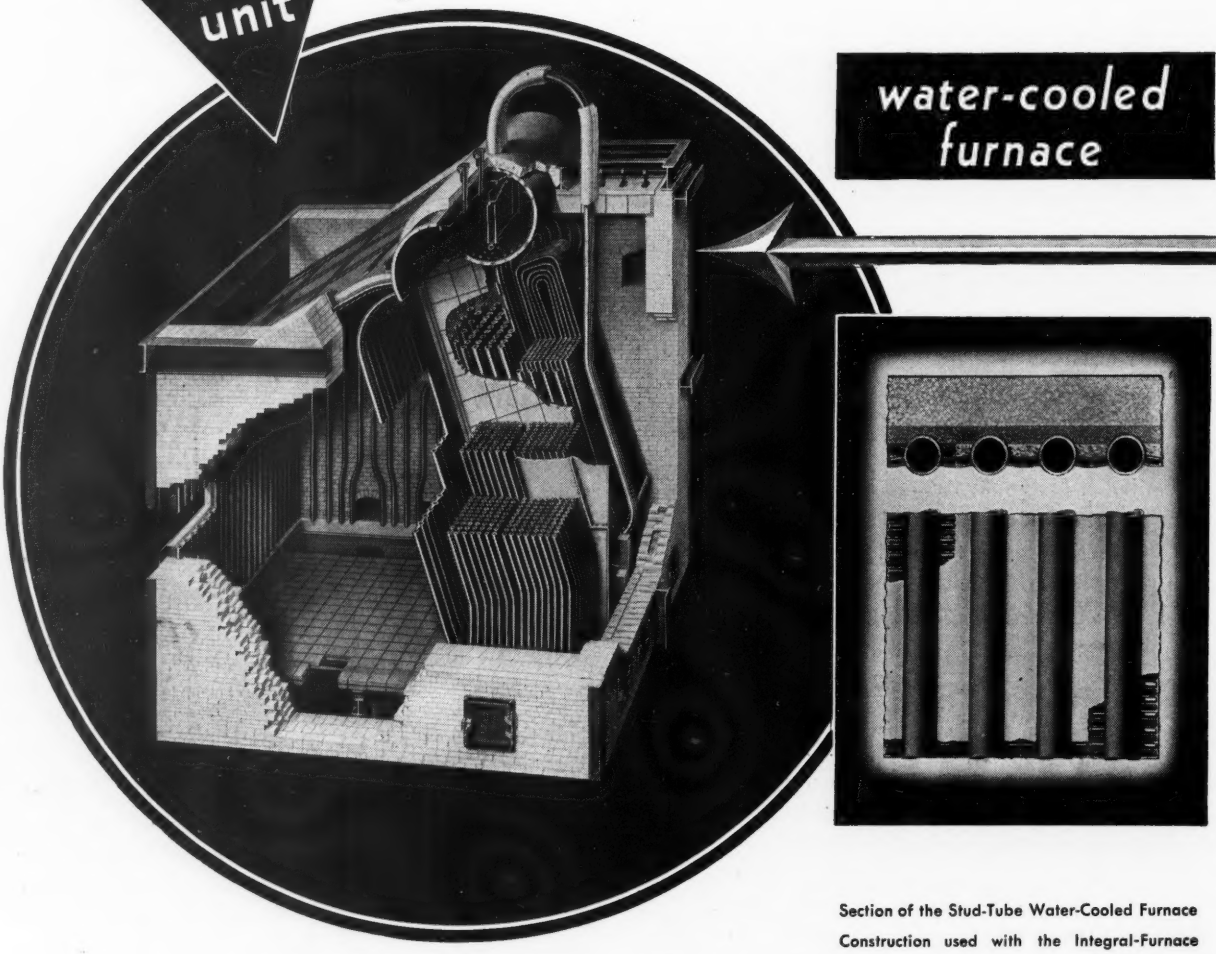
BABCOCK & WILCOX

R-26

a complete boiler unit

for lower steam

water-cooled furnace



The B&W Integral-Furnace Boiler . . . a complete, well-balanced unit, including boiler, superheater, water-cooled furnace, fuel-pulverizing, burning, and control equipment . . . has advantageous features heretofore available only in equipment for the largest plants. The newness of this unit lies merely in the manner of assembly of the various thoroughly proved constructions utilized. High operating efficiency is obtained regardless of the fuel used, because of the design of the water-cooled furnace, the cross-flow of gases, the use of smaller tubes in the second and third passes, and to the effective slag screen, which effectively prevents the accumulation of slag on the heating surfaces when pulverized coal is the fuel.

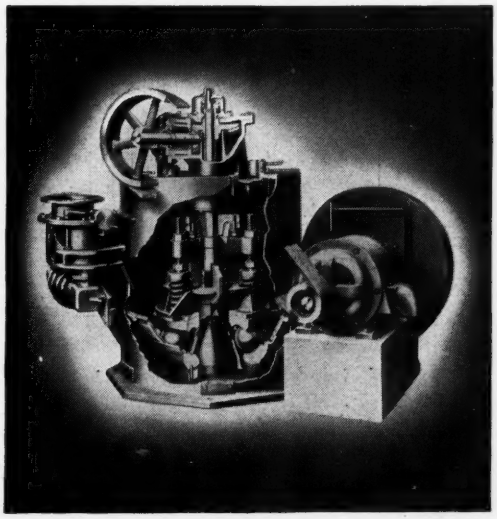
Section of the Stud-Tube Water-Cooled Furnace Construction used with the Integral-Furnace Boiler. This construction assures low maintenance, minimum outage for repairs and replacements, and high availability. It fills all the requirements for economical and trouble-free operation with pulverized coal, through the maintenance of temperatures high enough to assure quick ignition and rapid combustion and low enough to prevent excessive slagging of the boiler tubes, and yet is equally suitable for oil or gas fuel.

THE BABCOCK & WILCOX

costs in industrial service..

coal pulverizer with feeder and blower

the INTEGRAL FURNACE BOILER



The B&W Type B Pulverizer with integral feeder and blower . . . an important component of the Integral-Furnace Boiler with pulverized-coal firing. This pulverizer employs the ball-bearing principle of grinding, the most efficient method yet developed, and with which operation at relatively low speed, consistent performance in capacity and fineness of the coal delivered, and low power consumption are assured. Maintenance is unusually low . . . the simple design includes but few wearing parts, and these are of wear-resisting materials that extensive experience has proved best for this service.

The development of the Babcock & Wilcox Integral-Furnace Boiler has been timely, for it offers, at a critical time in plant operation, the best unit yet developed for generating steam in small and moderate quantities, and at an over-all installed cost that is surprisingly low.

The engineering skill and experience of The Babcock & Wilcox Company were focussed on this design to produce a boiler unit that would definitely decrease the cost of generating steam and thereby increase the margin of profit of the average industrial plant.

The unit has already proved that it accomplishes this purpose. Of the 12 units sold, several have been in service sufficiently long to effect impressive reductions in the cost of power and process steam. A cotton mill, for example, (cited only because of complete engineering tests) now produces steam at an overall fuel rate of 1.2 pounds of coal, or 17,200 B.t.u., per kilowatt hour. Other comparable reductions are being made in other installations.

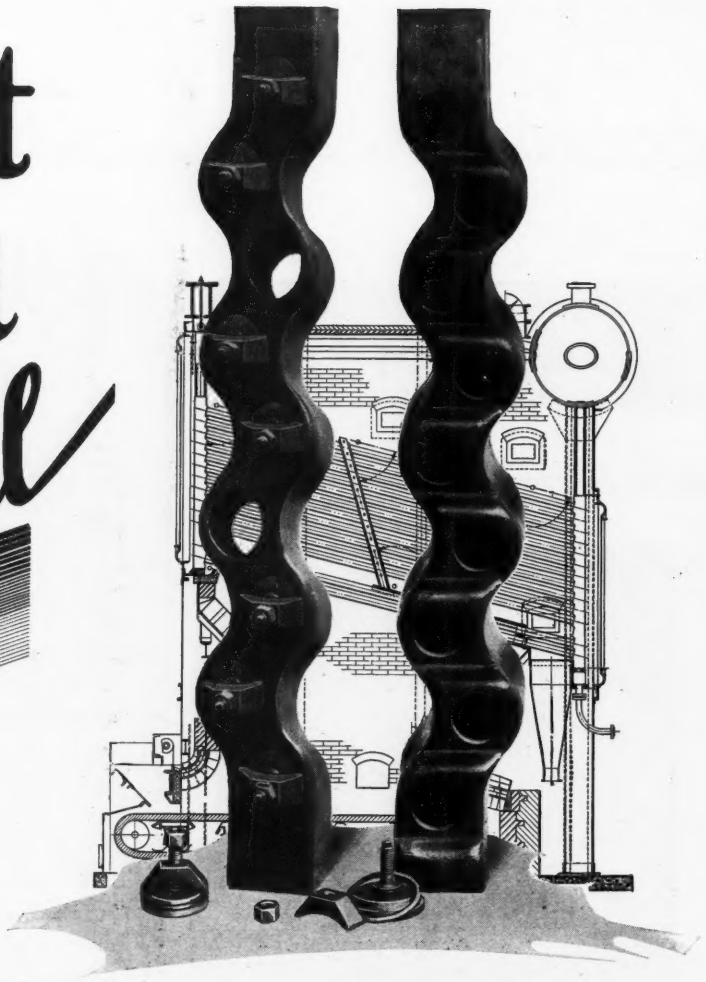
Investigate the possibility of making savings in your plant with the Babcock & Wilcox Integral-Furnace Boiler . . . ideal for the replacement of obsolescent and inefficient equipment, because of the simplification of operation and assured low cost of steam. Address The Babcock & Wilcox Company, 85 Liberty Street, New York.

COMPANY

WRITE FOR THIS FULLY ILLUSTRATED 20-PAGE BULLETIN.

G-57-T

Vogt forged Steel



SECTIONAL HEADER BOILERS

Manufacturers of: Water Tube Boilers, Drop Forged Steel Valves and Fittings, Oil Refinery Equipment, Ice Making and Refrigerating Machinery, Heat Exchangers.

ATTENTION . . . buyers of forged steel sectional header boilers!

Time and research has enabled us to develop a highly improved forging process for the production of uniformly better header forgings, the heart of this recognized standard design. Fitted with drop forged steel handhole plates and yokes, nothing has been left undone to offer you a product of unquestioned superiority.

A complete range of sizes, with cross or longitudinal drums as preferred, enables us to quote on any desired capacity.

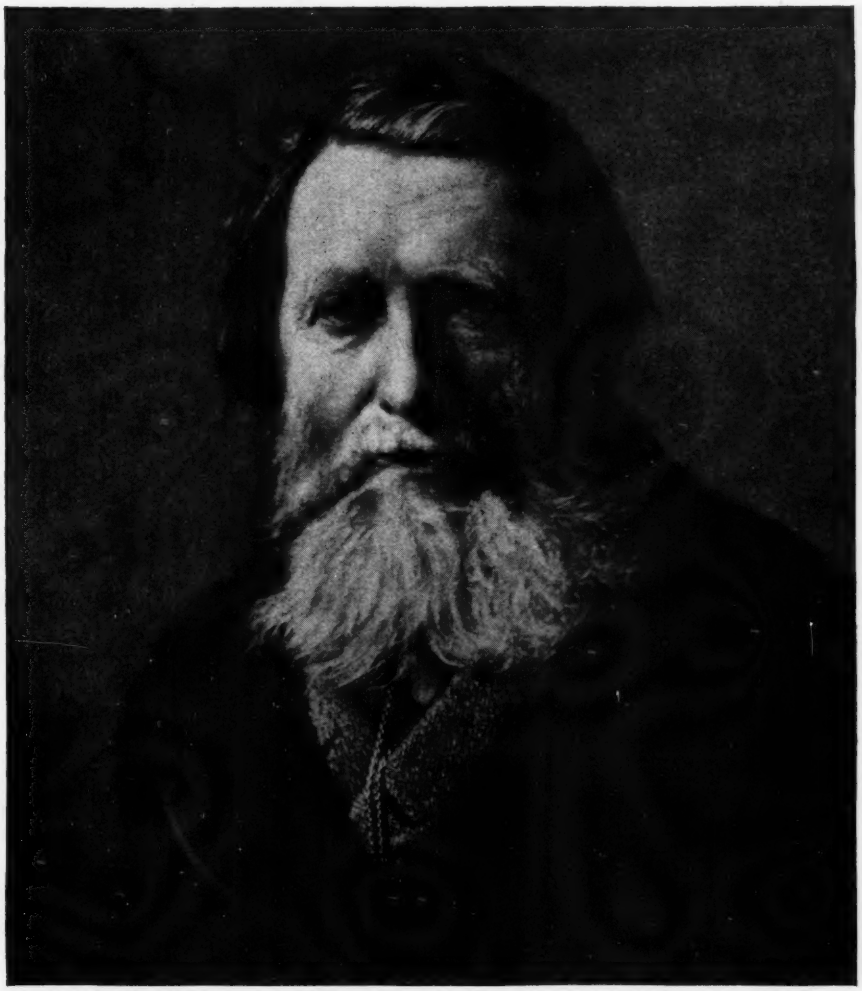
Henry Vogt Machine Company

Incorporated

LOUISVILLE, KENTUCKY

NEW YORK ◆ CHICAGO ◆ PHILADELPHIA ◆ CLEVELAND ◆ CINCINNATI ◆ DALLAS ◆ KANSAS CITY

• • • There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only, are this man's lawful prey. **—RUSKIN**



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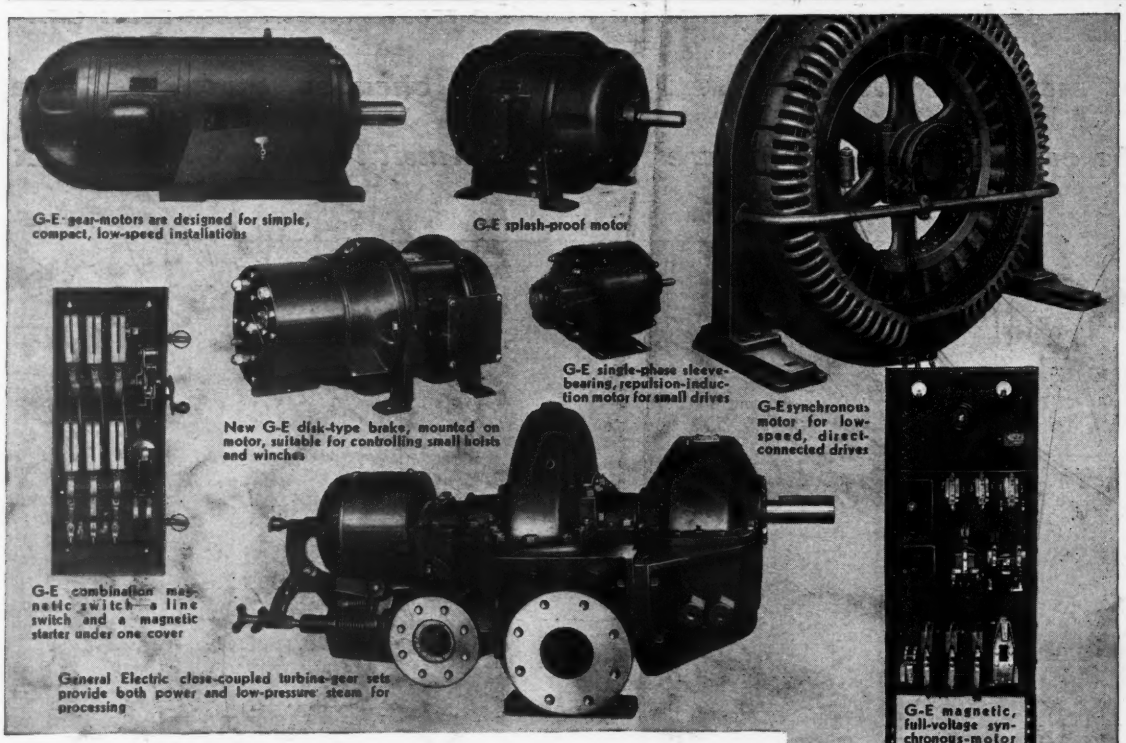
A-932

SUPERHEATERS • AIR PREHEATERS • GRIFFIN HOT BLAST • WATER WALLS • ECONOMIZERS


G-E gear-motors are designed for simple, compact, low-speed installations
G-E splash-proof motor
G-E single-phase sleeve-bearing, repulsion-induction motor for small drives
G-E synchronous motor for low-speed, direct-connected drives
New G-E disk-type brake, mounted on motor, suitable for controlling small hoists and winches
G-E combination magnetic switch—a line switch and a magnetic starter under one cover
General Electric close-coupled turbine-gear sets provide both power and low-pressure steam for processing
G-E magnetic, full-voltage synchronous-motor controller
G-E manual motor-control switch for full-voltage starting of small motors
G-E vertical, protected-type, induction motors are especially designed for deep-well pumping
G-E squirrel-cage induction motor, with pulley and sliding base

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